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Certainties and Uncertainties

WHEN ASKED, "Is business better?", most manufacturers with whom we have talked will usually admit that there has been some noticeable improvement in recent months. Most inventories are down to normal or sub-normal levels. There have been favorable price adjustments on some raw materials. Men are anxious and willing to work, except in a few strike-infested localities. What, then, is holding up the orders that mean more business in so many plants? The answers one most often hears are questions of uncertainty about the attitude of government toward business, about the threat of further federal reforms, and the futility of spending our way back to prosperity with public funds. Admittedly, these uncertainties are serious and discouraging obstacles in the path of business recovery. Yet a few manufacturers are beginning to find that there are ways of getting around them.

The technique, as recently outlined to the New England gas industry by Professor E. H. Schell, of M.I.T., is extremely simple. It consists first in acknowledging the presence of an uncertainty. Second, in determining its scope and the extremes of its probable influence. And, third, in designing a program sufficiently flexible to compensate for or control these possibilities. Thus the uncertainty—or at least its influence—comes under control and its hazards of fear and surprise have been eliminated.

Offsetting all current uncertainties are five fundamental certainties that we must not lose sight of in planning future business activities. All of them are assets of special significance to the chemical engineer. First is the certainty that we are in the presence of relatively rapid change—that our thinking must be on a dynamic rather than a static basis. Second is the certain knowledge that human wants are fast increasing, provided our goods are better and cheaper. Third is the almost universal recognition that organized research is a dominant, competitive weapon for attacking any problem. Fourth is the great resource of good will which most of our industries have carefully built up and jealously preserved. Fifth, and most impelling of all, is the certainty that private industry as it is now constituted must and surely will continue as the fundamental basis of our national economy.

All this advice, it seems to us, is peculiarly applicable to the chemical process industries. In previous depressions they have demonstrated ability to solve their own problems. They have been resourceful in their research and quick to turn the developments of the laboratory into the dollar profits of daily business. They have learned from experience that it pays to make constantly higher quality available at constantly lower prices. They have been fortunate in securing the confidence and support of their employees and stockholders as well as the good will of their customers and of the communities in which they operate. Finally, the public at large recognizes chemical industry as a progressive champion of scientific progress—as vital to the public health as to the national defense.

What is needed today is the application to current difficulties and uncertainties of some of the same energy, resourcefulness and ability that our industries have used so effectively in the past. Depressions and recessions, so regarded, are just a few more problems for those who are looking to their research and engineering developments for prompt and profitable answers.

From an EDITORIAL VIEWPOINT

ANOTHER UNCERTAINTY ELIMINATED

AN INCREASE in industrial construction is certain to result from the new tax law in the opinion of Washington representatives of industries who have followed this legislation most closely. Freed from the requirement of paying a high tax on earnings withheld from dividends for the purchase of new equipment or for new plant construction, it is believed that deferred disbursements for capital purposes will begin soon—despite the depression. Changes in the provisions for taxing capital gains are also expected to make it easier to sell equities and securities that will provide capital funds for improvements and plant expansion. If this proves true we shall have Senator Harrison to thank for his courageous stand.

A BRIGHT SPOT

AMONG the process industries, petroleum is most fortunate because its principal product is in universal demand. Thus it can steer a steadier course between the peaks and valleys of depression. Typical of its good fortune is the fact that the domestic demand for motor fuel in the first quarter of 1938 was two per cent above that for the first quarter of 1937. Export demand was up about a third over the corresponding period of last year. These cheerful facts come from President Byles' report to the American Petroleum Institute's mid-year meeting at Wichita. Equally encouraging were the many fine papers on the advance of the technology of petroleum refining. It would seem that better times are back again in the oil business.

POWER FOR THE FUTURE

WORD FROM the Massachusetts Institute of Technology of the establishment of the Solar Research Fund is an announcement as stimulating to the imagination as any in recent memory. Using the income from a generous gift donated by Dr. Godfrey L. Cabot, the Institute is planning an exhaustive investigation of the feasibility of, and methods for, converting solar energy to usable forms by chemical, physical, electrical and mechanical means. A similar gift made last year to Harvard will be devoted to accelerating such conversion by botanical means. Thus a subject which has long been a fertile source of speculation and vastly intriguing to engineers and pure scientists alike will now be opened to thorough canvassing and scientific study.

Which of the three energy sources: solar radiation, the sun's magnetic field, or the energy still inextricably locked in the atom, will eventually supply the earth's fuel and power nobody can guess. Perhaps it will be none of the three, but the earth's heat or some source not even conjectured as yet. Nevertheless, geologically speaking, the time is not far distant when our now existing oil, gas and coal will have dwindled to the vanishing point and our descendants may have need of a much quicker means of capturing solar energy than the painfully slow process by which the coal measures were laid down.

Even today, of course, nearly all our energy derives from the sun. Ill-fated Quoddy would have owed its energy to the moon, but solar radiation is directly responsible for coal, falling water, wind and wave power, power alcohol and other vegetable derived fuels, and probably for oil and gas. But if nature is inexorable, it is also far too leisurely for the present-day tempo. Natural processes make available very little of the 16,000 odd B.t.u. of solar power falling on every square yard in the temperate zone during an average summer day. With so much energy going to waste even a relatively inefficient conversion process would suffice, provided only that it could be carried out at reasonable cost for equipment and operation.

NEW SALES OPPORTUNITY

IT LOOKS AS THOUGH fertilizer makers, including the suppliers of fertilizer chemicals, and the manufacturers of insecticides have a new selling job to do. This has come about as a result of continuous growth in the importance of food manufacture as an element in the use of both fertilizers and insecticides.

Not only the food canner who "tins" fruits and vegetables, but also many other food processers are increasingly dependent on high quality materials from agriculture. To insure that they get these, the food processers are going back to the farm in their educational efforts. They are seeking with their farm contracts to develop more aggressive and more economic agricultural practice, with the use of abundant quantities of fertilizers and insecticides.

Makers of these chemicals should take advantage of this trend of thinking. They should

begin to study the needs of the crops of peas and corn for the canner, of sugar beets and of a dozen other types of crops for which agricultural chemicals are required. And with some knowledge of what the ultimate user ought to do, they can go to the food processers and help them put into practice the best techniques of modern agriculture. Incidentally, but importantly, the object is to sell more of the agricultural chemicals, a result which can reasonably be expected from a studious program, developed with real understanding of fundamental agricultural economics.

DOES IT REALLY "COST TOO MUCH"?

PROBABLY not more than one engineer in ten has even the remotest idea of the actual cost of fine silver equipment—at least that is what Dr. H. C. Parmelee discovered as the result of a little survey for *Engineering & Mining Journal*. Many persons have some vague idea that the price of silver is comparable with that of gold, with which it is so often associated in monetary systems and in jewelry. In reality it may be purchased at one-eightieth the cost of the precious metal. The open market price of $6.50 per avoirdupois pound puts it in the reach of the engineer for use in constructing equipment for numerous purposes in the chemical industries. Not only is its use economical for plated parts and bi-metallic linings but also for entire pieces of equipment. While silver now finds scattered applications in a comparatively few plants, in all probability its use for industrial purposes would be far more general if it were possible to dispel the illusion that "it will cost too much."

NEW PAINT OILS

PAINT specifications are undergoing gradual change. These changes must take place to accommodate new paint oils. Recent developments indicate that the trend will be accelerated, and it is to be hoped that this will be done without sacrifice of sound principles.

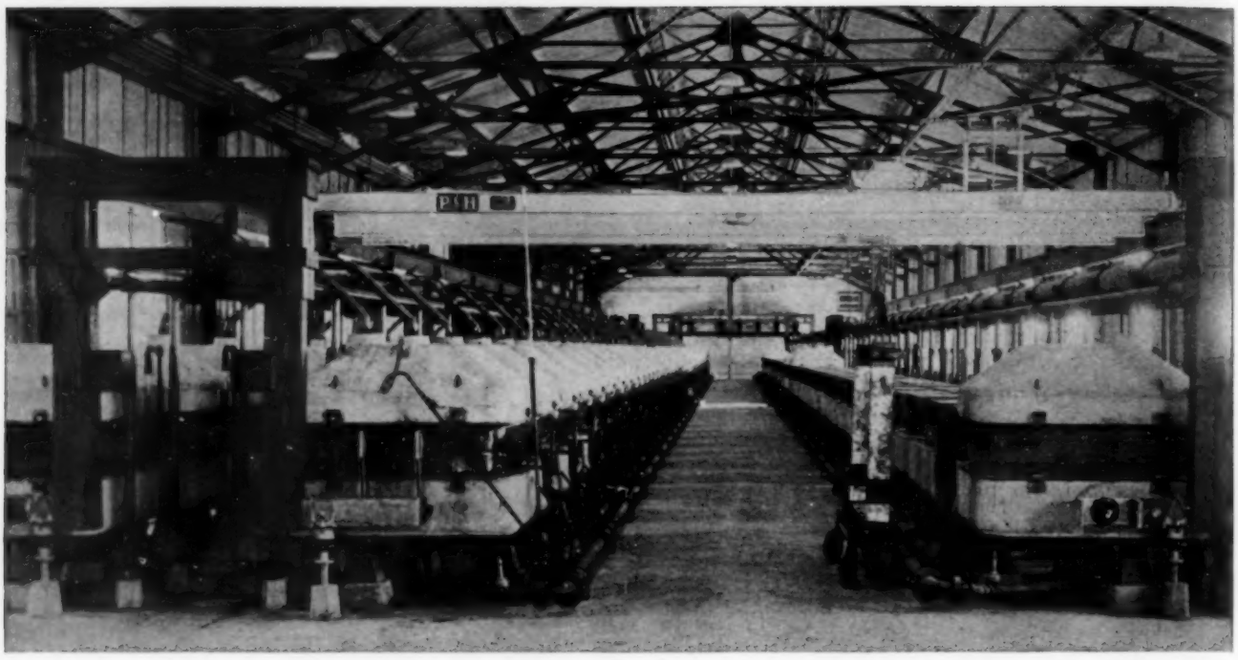
Most specifications for outside house paints in use today are written around the idea that linseed oil will be available. All of the tests, iodine number for example, are complied with when a first-rate linseed is used. Other oils usually will not comply at all, or with difficulty. And yet other paint vehicles should often be employed, because of the shortage, real and threatened, of linseed supplies.

Already specifications for inside paints, for lacquers and enamels, take account of new oil vehicles. This has been necessary for economy in manufacture and use, as well as to achieve special characteristics wanted in modern finishes. As yet the substitution of other oils, soybean for example, has not gone far in outside paints. It should not do so without careful preparation to ensure that poor quality and short life will not be an accompaniment of economy.

Public interest demands progress in these matters. We should encourage the domestic paint oil in its competition with linseed, just as fast as it proves its worth. This will augment the cash crops of American agriculture. It should also cheapen the paint; but it must not come through sacrifice of quality. The job is not altogether easy, but paint technologists working with oil chemists will find a way to the advantage of all, including the paint industry itself.

ELON HUNTINGTON HOOKER, 1869-1938.

WITH THE DEATH on May 10 of Elon Hooker, chemical industry lost something more than a distinguished executive and able leader. He was one of the few that have carried their influence far beyond the industry. Social and civic groups, educational and economic circles and even political parties benefited immensely because of his participation in their activities. Like his great friend, Theodore Roosevelt, whom he admired so much and with whom he worked so closely for many years, Elon Hooker had a colorful and purposeful life. A graduate engineer, with a doctor's degree in his own right, he had a true appreciation of the importance of technology; yet he had none of the limitations and inhibitions of the highly trained specialist. He founded his own company and for 35 years guided it to ever greater achievement. He was president of the Manufacturing Chemists' Association for three consecutive terms. He headed the Research Corporation for many years and up to the time of his death was an active executive of the National Industrial Conference Board. A true citizen of America, he carried forward the finest traditions of that distinguished ancestor, Thomas Hooker, who just 300 years ago founded, at Hartford, the Colony of Connecticut.



Four rows of Hooker electrolytic chlorine cells (180 in all) in the Corpus Christi plant of the Southern Alkali Corp.

Chlorine Is Produced in the Southwest

By JAMES A. LEE
MANAGING EDITOR
CHEMICAL & METALLURGICAL ENGINEERING

EVEN before the "smart fellows in Wall Street" saw the turn for the better in business conditions way back in 1933, the keen foresight of the president, H. A. Galt, and other executives of the Southern Alkali Corp. decided it was time to go ahead with their plans for a plant in the Southwest. A plant site of 65 acres at Avery Point, just west of Corpus Christi, Texas, had been chosen for this subsidiary of the American Cyanamid Co. and the Pittsburgh Plate Glass Co. In the fall of 1934 this modern ammonia-soda plant commenced the production of light and dense soda ash, washing sodas, liquid and solid caustic soda. For accounts of the ammonia-soda plant, see *Chem. & Met. Eng.*, Vol. 41, pp. 253-56, and pp. 412-13, 1934.

The enormous increase in the demand for chlorine from the kraft pulp industry, which is developing so rapidly in the South and Southwest, led the Southern Alkali Corp. to add an electrolytic department to its plant at Corpus Christi. This new plant commenced operations March 1 of this year. It was constructed at a cost of approximately $2,000,000. There are 180 Hooker Type S cells. A description of the cell will appear in an early issue of *Chem. & Met.* While most of the output of chlorine will be consumed in bleaching operations by the kraft pulp mills along the Gulf Coast, some of it will be used for water purification, the manufacture of chemicals, and other applications. A market for the electrolytic caustic is found in the petroleum refineries and other industries. At the same time a salt plant was added to care for the increasing demand for this product, particularly the large tonnage which goes into the wool industry.

The source of the brine is the company's own wells on the Palangana dome at Benavides, Texas. Although it is 61 miles from the chlorine plant, the disadvantages of such a great distance are largely offset by the fact that the dome is at a sufficient elevation above the plant site as to permit of gravity flow and thus obviate the necessity for pumping the brine. It reaches a pressure of 225 lb. per sq. in. at the plant. The pipe line is 14 in. cast iron, mechanically jointed. On arriving at the plant the brine is stored in a 3,000,000 gal. open reservoir or goes to a head tank.

From the head tank it is pumped into an agitated reaction tank, located outside of the chlorine department, in which it is treated with caustic soda and soda ash in order to precipitate the calcium and magnesium salts. Some salt produced in the evaporation of the electrolytic liquors can be dissolved and added to this tank and will probably thus be used from time to time. The soda ash is pumped over to a storage tank, located outside the chlorine cell room, from the ammonia-soda department.

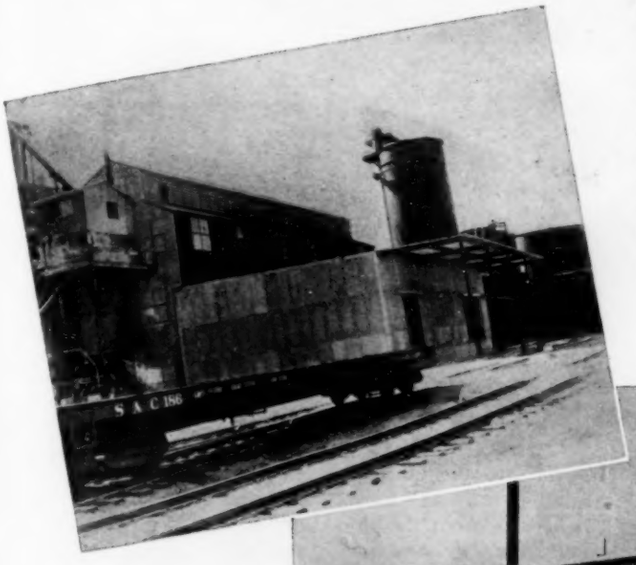
The caustic soda solution is obtained from cell liquor. The overflow from this reaction tank goes to thickeners. The effluent flows into sand filters. The filtrate from the bottom of the sand filter is acidified with hydrochloric acid in a rubber-lined reaction tank. This acidified brine is pumped to storage and from there it goes to a general head tank feeding the cells. It is essential to keep a very constant head on the cells. In order to control the temperature of the brine as it enters the cells it is heated to 75 to 80 deg. C. in automatically controlled preheaters on its way to the head tank.

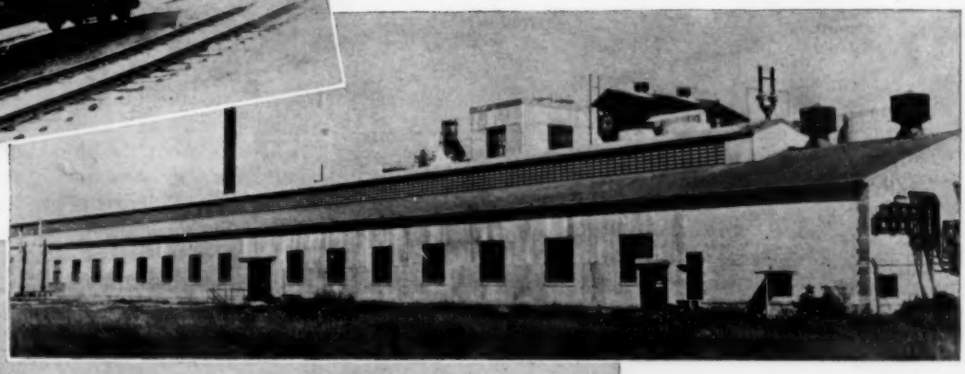
The brine is fed into the cells through tantalum orifices, one to a cell. The cell liquor contains 130 gm. of caustic soda and 165 gm. of salt per liter. As the chlorine leaves the cells it passes through a ceramic pipe line located above the cells. This line is connected with a rubber-lined steel pipe at a point level with the bottom of the cells. Hydrogen passes through steel pipe and is exhausted into the air. Caustic soda flows by gravity into a sump tank below the cell room. From here it is pumped into storage to be fed to Swenson evaporators.

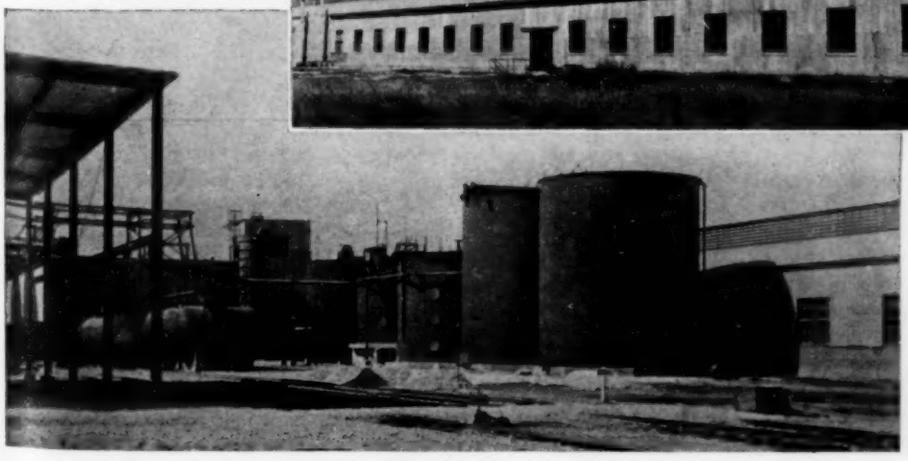
The chlorine is drawn through rubber-lined pipe to three coolers in series in which the temperature is reduced to about 20 deg. C. The cooling medium in the first and second coolers is sea water and in the third it is brine. A Nash vacuum pump pulls the chlorine through the entire system and compresses the cooled gas to 30 lb. per sq. in.

From the coolers the wet gas passes through two drying towers arranged in series. The first is a stoneware packed tower and the second acid-resisting brick lined tower packed with brick. The wet gas passes upward countercurrent to sulphuric acid which is used as the drying agent. The acid enters the second tower at 66 deg. Bé and leaves it at 62 deg. Bé, varying with the rate of production, to be pumped after cooling to the first tower. The weak acid leaving the first tower is not recovered at present. Duriron pumps are used wherever sulphuric acid is handled. Sea-water-cooled steel heat exchangers are used to cool the acid. After passing through the Nash pump the acid used to seal this pump is separated from the gas in a large steel separating tank and returned to the pump.

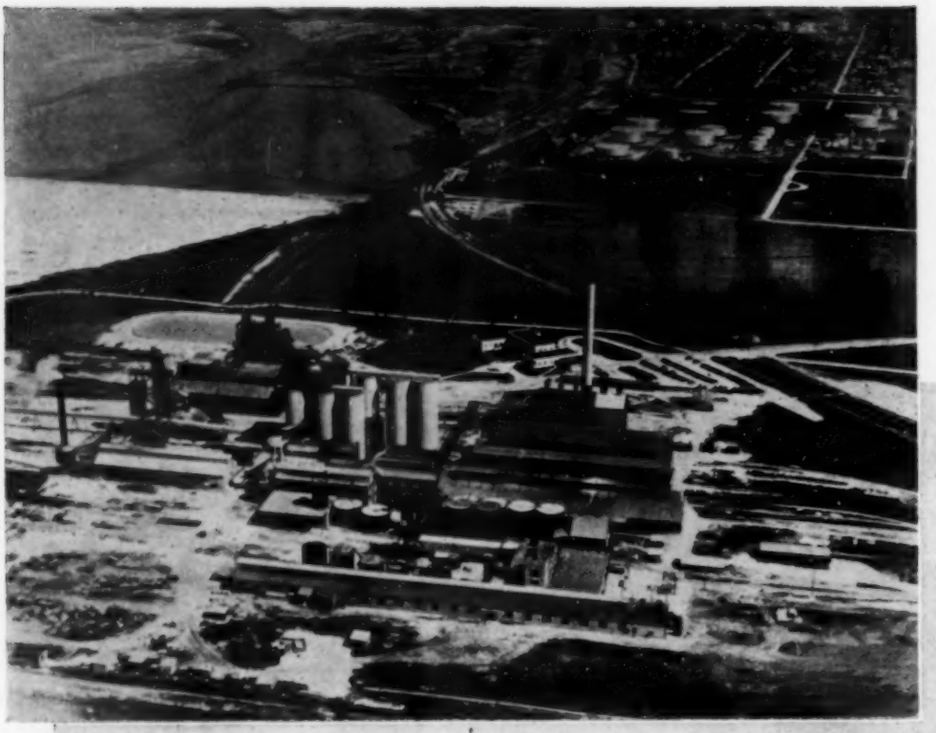
The dry chlorine is then forced into the primary tubular condenser. Here a calcium chloride brine cooled by ammonia refrigeration to —18 deg. C. is used. The liquefied chlorine flows by gravity to the platform scale tanks which are used to weigh production and for temporary storage. The gases containing a small volume of uncondensed chlorine pass through the secondary tubular condensers cooled to about —25 deg. C. by carbon dioxide. The chlorine which is liquefied in this secondary condenser also flows into the platform scale tanks. There are three 40-ton weigh tanks. Loading is done from these tanks or from the four reserve storage tanks on the outside of the building. Air dried in an electro-dryer is used to blow the liquid chlorine from storage into ship-







Top—Salt recovery and storage buildings. Above—Electrolytic cell room with transformer department on the right. Left—Brine is treated in the reaction tanks and thickeners and passed through sand filters before going to the head tank feeding the cells



Southern Alkali Corp.'s Corpus Christi, Texas, plant showing ammonia-soda department in rear and the new electrolytic chlorine and salt plants in the foreground. Below—Chlorine plant showing storage tanks and tank car loading at left and end of cell repair building at right

ping containers. It is shipped in 100 and 150 lb. steel cylinders, single unit tank cars of 60,000 lb. and 32,000 lb. capacity, multi-unit tank cars of 15 one-ton units.

From storage the caustic soda is conveyed to the double-effect Swenson evaporator with pure nickel tubes and Ni-clad bodies. The evaporators are equipped with high velocity nickel circulating pumps. The discharge containing 30 per cent caustic passes to a settler where salt is removed and the clear liquor goes to a single-effect evaporator. Here the caustic is evaporated to 50 per cent concentration. In another Ni-clad settler additional salt is removed. The overflow is cooled by refrigeration in Vogt chillers to a temperature slightly above the solidification point, passed through a Vallez filter for salt removal and sent to storage.

The 50 per cent caustic may be evaporated to 70 per cent in the single-effect evaporator, fed to the cast iron, gas-fired pots of Goslin-Birmingham manufacture, and concentrated to anhydrous. This concentrated mass may then be pumped into drums or over a chilled flaking wheel. The flaked caustic is crushed, screened and packed into packages of various size flakes.

The salt from the 50 per cent slurry is filtered out and returned to the 30 per cent salt settler following the double effect.

The salt from the thickeners is conveyed to the salt plant where it is washed with purified brine and dried in an Oliver-Robinson top feed filter. This is a rotary vacuum filter equipped with a Ross gas-fired air heater. The temperature is automatically controlled. The dried salt drops onto a conveyor and is carried to storage. This salt is either redissolved for cell brine or is sold for industrial purposes as "stock" salt.

The cell building is covered with Gypsteel roofing. The three permanent sides are covered with corrugated asbestos-cement siding while corrugated galvanized iron is employed on the fourth side which will be removed when and if expansion of plant capacity becomes necessary.

Direct current supply required for the electrolytic cells made it necessary to furnish mercury arc rectifiers and accessories to effect the conversion from the generated a.c. voltage of 2300. Transformers were also required to reduce the voltage to values appropriate for application to the rectifiers which are designed to deliver 600 volts d.c. to the cells.

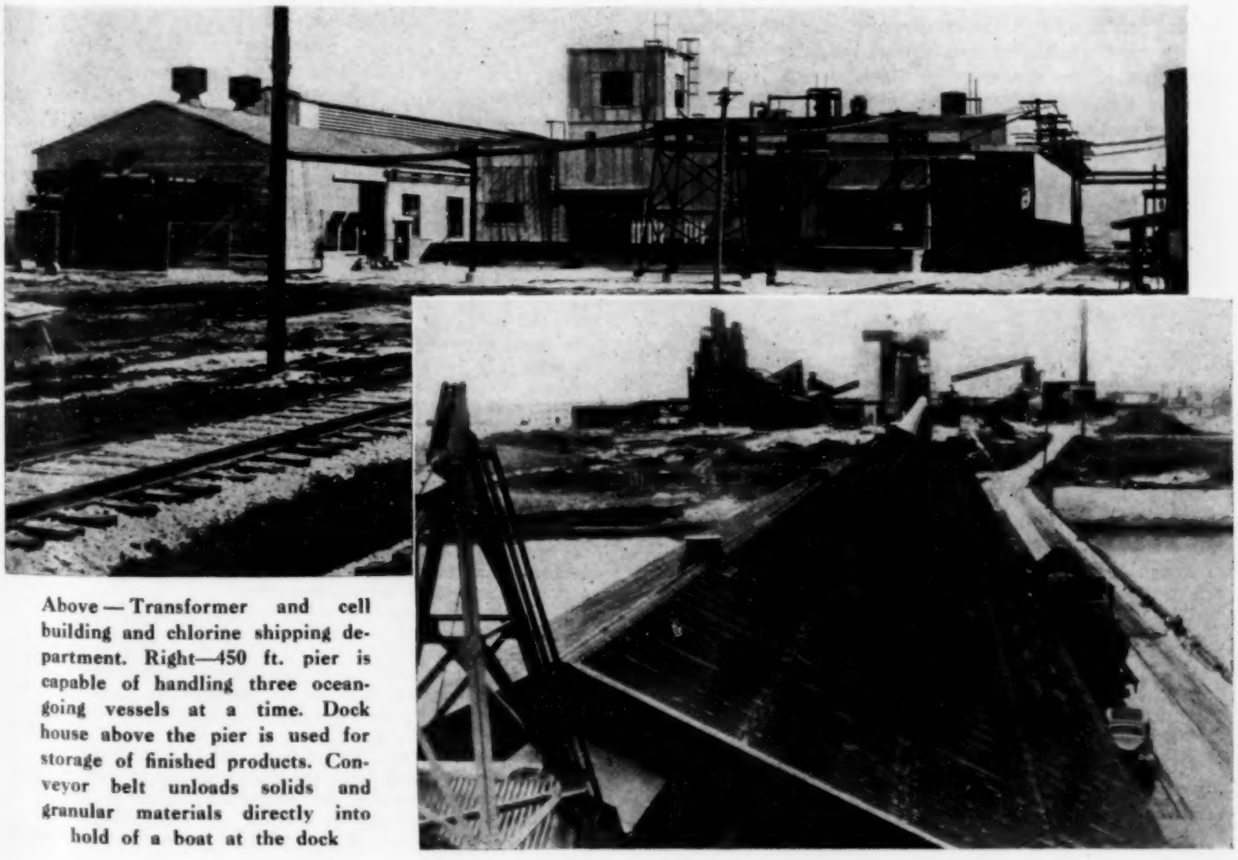
The mercury arc rectifiers were chosen because of their low operating cost, high efficiency and their suitability in corrosive atmosphere. These rectifiers require less attendance and are less susceptible to corrosion of working parts that can cause failures. Another advantage is that they are foolproof against reverse polarity, which is highly dangerous, and operators require no special training for routine operation. Experience with the use of this type of equipment is discussed by L. J. Rimlinger of the Pittsburgh Plate Glass Co. in the Jan. 29, 1938 issue of *Electrical World* and by W. E. Gutzwiller in *Chem. & Met. Eng.*, Vol. 43, pp. 434-35, 1936.

The plant is adequately served by both rail and water. Several miles of spur track and railroad switches parallel the plant and converge into the main line of the Missouri Pacific Railroad System. A pier 450 ft. in length and 100 ft. in width extends out into a 32 ft. deep channel. It is capable of handling three ocean-going vessels at a time. Above the pier is a dock house, 50 ft. x 450 ft., for storage of finished products. For solids or granular material, there has been installed a conveyor belt which can unload directly into the hole of a boat at the dock. This conveyor has the light soda ash capacity of 250 tons per hour. Piping arrangements are conveniently located for ship-tanker loading of liquids. Near the pier is the pumping station where large electrically driven centrifugal pumps handle the 50,000,000 gal. per day of sea water required for cooling purposes in the entire plant.

Fresh water is supplied from the Nueces River and pumped to the earthen reservoir belonging to the plant. Sea water for cooling purposes is taken from the ship channel and pumped throughout the plant. An automatic chlorination system was installed to treat the sea water to prevent troubles due to algae, slimes, mussel growth and other minute marine life. The results of tests have indicated a decided advantage in favor of continued chlorination. Lower friction losses and far less troubles due to valve stoppage, small lines plugging, and other innumerable small items of trouble and expense were brought about by the regular chlorination treatment. Tuberculation on outside atmospheric coolers has also been materially reduced by this treatment resulting in better heat transfer.

The machine shop, one of the largest in the Southwest, is unusually well equipped not only to make repairs but to fabricate tanks and other apparatus. Large machine tools, electric and gas welding, metal spraying and cutting equipment, boiler and sheet steel repair shops and a large storage warehouse, all are served by an overhead traveling crane.

The visitor to the plant is greatly impressed by the unusual and attractive combination office and chemical laboratory building. The brick and stucco structure is of Spanish architecture in keeping with the design predominating throughout southwestern Texas. A dining room, clinic and dispensary are also housed in this building. It is here that one finds the office of O. N. Stevens, vice president and general manager of the Southern Alkali Corp., to whom the writer desires to express his appreciation for the courtesies shown during the visit to Corpus Christi last month.



Above — Transformer and cell building and chlorine shipping department. Right—450 ft. pier is capable of handling three ocean-going vessels at a time. Dock house above the pier is used for storage of finished products. Conveyor belt unloads solids and granular materials directly into hold of a boat at the dock

Adsorption, Absorption and Condensation In Recovery of Solvents

By CLAUDE A. BULKELEY

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CONSIDERATION of solvent recovery in connection with manufacturing operations may become of interest for a variety of reasons. Sometimes the ever-present odor of an escaping solvent will suggest that perhaps it should be recovered. More often, excessive cost of lost solvent will dictate that something be done about the condition and then it becomes necessary to determine, first, whether recovery is actually feasible from the cost standpoint; second, whether the process is such that recovery must become essentially a part of the manufacturing process; and third, assuming that some form of recovery is desirable, which of several possible methods is best adapted to the process at hand. Often it is found possible to use more than one method and it then becomes necessary to weigh the relative characteristics of the several methods, determine how each would affect other factors of the process, and evaluate each in terms of installation and operating costs, space requirements and recovery efficiency. Recoveries of 90 per cent or higher are generally obtainable. However, only if the net cost of the recovered solvent will pay for the installation well within five or six years should the investment be considered of value, unless other considerations of the process make the investment and savings of minor importance.

Such a case might occur, for example, when the requirement for a minimum of foreign particles in a gas or air circulating system precludes the adoption of other than a closed circuit. There is no practical method of removing all foreign matter from air so that, as in the manufacture of photographic film, a closed circulating system with some form of solvent recovery may become necessary, regardless of cost. Again, there are often opportunities to improve a process through the use of a more expensive solvent than could be used economically without recovery.

Three distinct methods are in use for the recovery of solvents: adsorption, absorption and condensation. The three methods are quite similar in principle, although they differ considerably in equipment and methods of operation. Furthermore, each of them is subdivided into a number of variations.

Adsorption Methods

Within fairly recent times a number of essentially porous solids have been developed which have a decided affinity for the adsorption of certain vapors, such as water, certain hydrocarbons, alcohols and derivatives. With most of these materials a selective preference is exhibited for the adsorption of certain vapors or groups of vapors. Examples of such adsorbents include a variety of activated carbons, silica gel and activated alumina. These materials in more or less granular form can be supported in beds of suitable thickness through which a vehicular gas inert to adsorption, such as air, is forced, carrying the vapors to be adsorbed. Under proper circumstances, adsorption is practically complete, even with extremely lean vapor content of the gases, and this method consequently lends itself well to recovery operations, particularly those which are conducted in the open by use of an exhaust system.

Activated carbon is at present the material most used for solvent recovery, since both activated alumina and silica gel have a selective preference for water vapor. The field for the latter therefore is chiefly in a variety of drying operations. Among the carbons, one type may have a particularly strong affinity for certain vapors, the adsorption of which may affect its capacity to adsorb others in the same operation. Consequently, the type best suited must be carefully determined. Adsorbents vary considerably in cost and performance. Furthermore, wide variations are possible in the type of set up of equipment best suited to the material and the particular problem in hand.

Depending on a variety of factors, adsorbents are generally able to take up from 8 to 25 per cent of their weight of vapors. The depth of bed required may vary from a few inches to several feet which, of course, affects the power consumption of the system. The effect of the adsorbent on the solvent is to accomplish condensation at a temperature much above that of saturation. In the process, the latent heat of the solvent vapor is given up to the adsorbent bed and to the unadsorbed gas or air (mostly to the latter, since the specific heat of adsorbents is relatively low) so that it may in some cases be necessary to cool the gas. In addition, it should be noted that both the capacity and efficiency of adsorption fall off with rising temperature of the bed. An important point in favor of carbon is that, since it is not selectively adsorbent of water vapor, little latent heat is released through such action and with a moist gas, less heating of both the exit gas and adsorbent bed occur. When steam is used for regeneration of a carbon bed, the moisture remaining in the carbon is immediately evaporated owing to its selective displacement by solvent vapor when adsorption is resumed, and the resultant cooling effect often makes a precooling period unnecessary.

Recovery is, of course, not completed with adsorption. To release the adsorbed solvent the adsorption bed must be regenerated, usually by heating the bed above the boiling temperature of the solvent at atmospheric pressure, by submerged heating elements or by circulating hot air, combustion gases or steam through the bed. The volatilized solvent is then condensed in a surface or other type of condenser and the gas returned to the adsorbers for the stripping of any uncondensed solvent. The recovered solvent from the condenser can be further purified by rectification and the regenerated adsorber cooled, if necessary, and returned to service. In some instances it is practicable to accomplish regeneration at lower temperatures

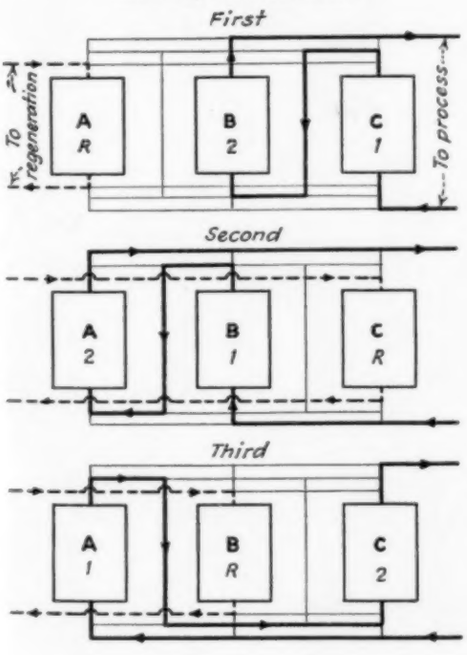
by application of a vacuum, in which case the need for a heat-carrying gas is eliminated. The volatilized solvent can then be condensed in vacuo. Sometimes adsorption can be accomplished at pressures higher than atmospheric.

Three types of arrangement of adsorbent units are in use, the type depending both on the performance ability of the adsorbent with relation to a particular solvent, and the requirements of the process. Generally two units suffice for continuous operation, for in most cases a single bed or series of beds of adsorbent is capable of trapping all of the solvent. In this case one unit will be in operation while the other is being regenerated. In discontinuous operations where there is a shut down period, say, every 20 hours, of sufficient duration to accomplish regeneration, a single unit may be sufficient provided that its capacity is adequate to recover all of the solvent. But for fully continuous operation where a second-stage adsorber is necessary to remove the solvent completely, the so-called three-step cycle must be used. This consists of a group of three interconnected adsorbers, two of which are operated on the recovery line in series, while the third is being regenerated.

Fig. 1 suggests diagrammatically the connections used in such a set up, showing how the connections are altered for the three steps of the cycle. In any one step the first adsorber in the line is the partially charged unit which was second in the line in the preceding step, while the second adsorber is the unit which was being regenerated in the preceding step. Meanwhile the third adsorber is undergoing regeneration (and cooling, if necessary). By this method each unit is rotated in turn through the three steps of regeneration, second stage and first stage adsorption and since the exit gas from the final adsorber should be practically free of solvent, it can be permitted to go to waste. The use of two adsorption stages permits utilizing the ultimate adsorption capacity of each unit, since as the first unit on the line approaches capacity and rises in temperature, any solvent escaping will be caught by the second stage fresh unit.

Generally speaking, an adsorption recovery system is relatively high in first cost, but usually pays a handsome return on the investment, with operating and maintenance costs that are low in comparison with the value of the recovered solvent. Small systems can be manually operated with efficiency equal to that of the larger systems, which should be fully automatically controlled.

Fig. 1—Diagram illustrating operation of three-step adsorber cycle



Absorption Methods

Whereas adsorbents are porous solids, absorbents are usually liquids, either materials which are liquid at the temperature of operation, or solutions of solids in some liquid vehicle such as water. Like adsorbents, they have an affinity for solvent vapors, causing their condensation at temperatures well above the saturation temperature. Unlike the former, however, they do not permit as complete stripping of the gas and hence may not give as high recovery efficiency, even when recirculation is used. A number of high-boiling hydrocarbons, alcohols and derivatives are used for absorption owing to their affinity for certain lower boiling solvent vapors. Among the solutions may be mentioned those of lithium chloride and calcium chloride, although these are used only for the absorption of water vapor from air or other gases for drying and air conditioning.

The absorption method, because it deals with liquids, generally permits the simultaneous continuous operation of the three steps of absorption, regeneration and rectification of the recovered solvent, although this is not usually done. The solvent laden vapor is passed through a bubble column, a packed tower, or a spray chamber, usually counterflow to the absorbent. Since the latent heat of the vapor is released during condensation, it must be removed either during absorption or in some other stage of the operation. This automatically takes care of itself when the solvent laden absorbent is continuously or even intermittently pumped to a regenerative process. Details of individual set ups vary so widely that further description is impossible here. However, it should be mentioned that the ease of continuous operation under more or less fixed operating conditions gives the absorption method an inherent advantage over adsorption in certain applications, especially where fairly rich vapor mixtures and a more or less completely closed system are required.

Condensation Methods

In methods based on condensation, the vapor laden mixture is cooled sufficiently to liquefy a portion by the lowering of the vapor tension. Thus they are distinguished from the means earlier described in which condensation is accomplished at temperatures above saturation. Two methods are used for cooling the gas: passage over extended-surface cooling coils; and passage through a chamber wherein a refrigerated liquid is atomized by spray nozzles under pressure. In either case the object is to cool the gas mixture to a predetermined temperature at which the vapor pressure of the solvent will be low enough to condense all but a permissible amount of the solvent remaining in the exit gases.

Although sometimes effective, the cooling coil method has certain inherent disadvantages in comparison with the atomized spray method:

1. The rate of heat transfer is relatively low for metal surface over which a gas is circulated, owing to the very low mass velocity of the gas, even at prohibitively high velocities. This entails the use of relatively large amounts of costly cooling surface.

2. The possibility that all portions of the cooling surface will not be at exactly the same temperature, and the difficulty of assuring uniformly intimate contact of gas and surface, make it difficult to insure uniform temperature of the gas without a thorough mixing procedure. Hence a more or less indefinite temperature-pressure relationship may obtain and at times

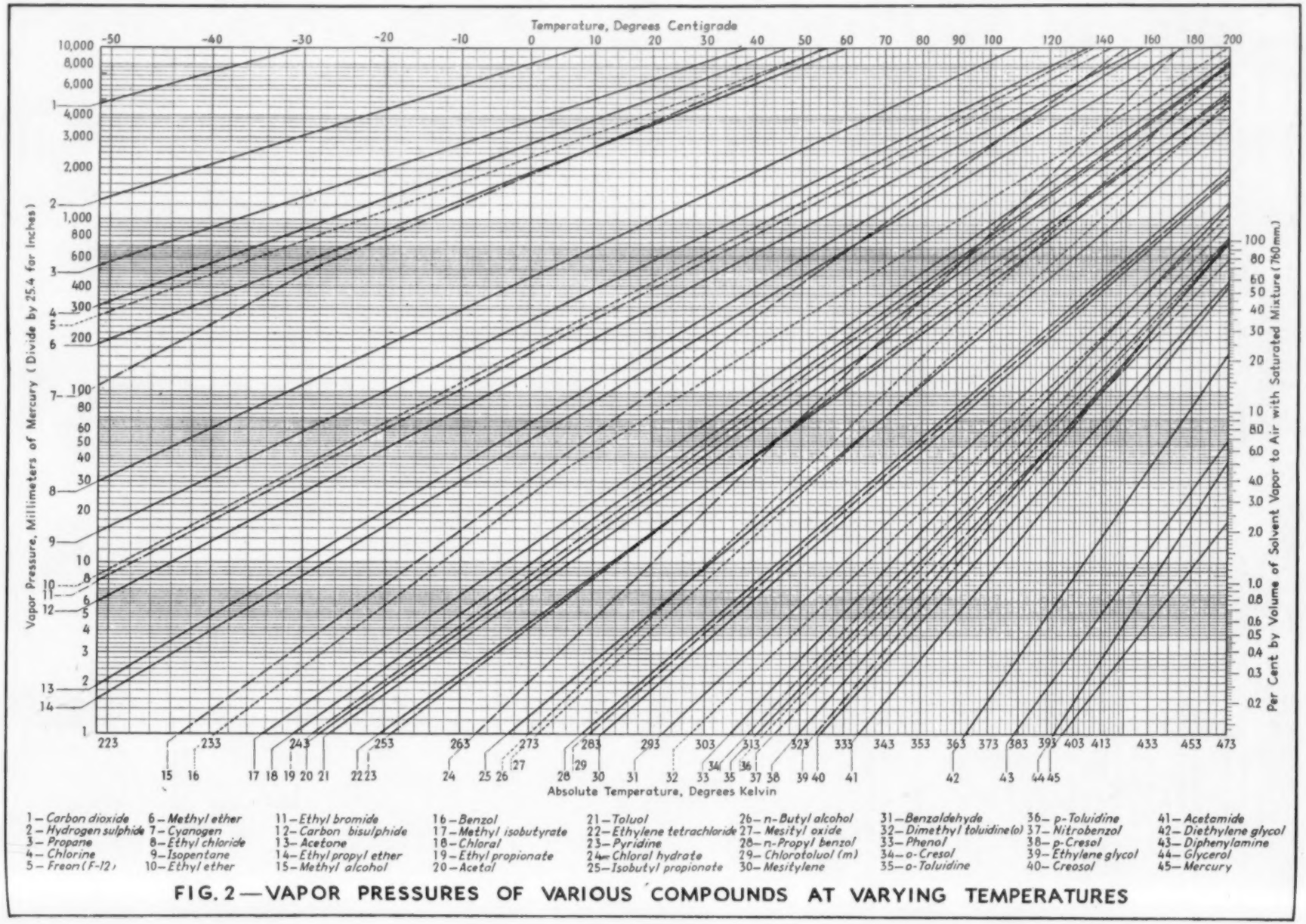

Temperature, Degrees Centigrade
-50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 120 140 160 180 200
Vapor Pressure, Millimeters of Mercury (Divide by 25.4 for Inches)
10,000 8,000 6,000 4,000 3,000 2,000 1,000 800 600 400 300 200 100 80 60 50 40 30 20 10 8 6 5 4 3 2 1
Per Cent by Volume of Solvent Vapor to Air with Saturated Mixture (760 mm.)
100 80 60 50 40 30 20 10 8.0 6.0 4.0 3.0 2.0 1.0 0.8 0.6 0.5 0.4 0.3 0.2
Absolute Temperature, Degrees Kelvin
223 233 243 253 263 273 283 293 303 313 323 333 343 353 363 373 383 393 403 413 433 453 473
1 — Carbon dioxide
2 — Hydrogen sulphide
3 — Propane
4 — Chlorine
5 — Freon (F-12)
6 — Methyl ether
7 — Cyanogen
8 — Ethyl chloride
9 — Isopentane
10 — Ethyl ether
11 — Ethyl bromide
12 — Carbon bisulphide
13 — Acetone
14 — Ethyl propyl ether
15 — Methyl alcohol
16 — Benzol
17 — Methyl isobutyrate
18 — Chloral
19 — Ethyl propionate
20 — Acetal
21 — Toluol
22 — Ethylene tetrachloride
23 — Pyridine
24 — Chloral hydrate
25 — Isobutyl propionate
26 — n-Butyl alcohol
27 — Mesityl oxide
28 — n-Propyl benzol
29 — Chlorotoluol (m)
30 — Mesitylene
31 — Benzaldehyde
32 — Dimethyl toluidine (o)
33 — Phenol
34 — o-Cresol
35 — o-Toluidine
36 — p-Toluidine
37 — Nitrobenzol
38 — p-Cresol
39 — Ethylene glycol
40 — Creosol
41 — Acetamide
42 — Diethylene glycol
43 — Diphenylamine
44 — Glycerol
45 — Mercury

FIG. 2 — VAPOR PRESSURES OF VARIOUS COMPOUNDS AT VARYING TEMPERATURES

FIG. 2—VAPOR PRESSURES OF VARIOUS COMPOUNDS AT VARYING TEMPERATURES

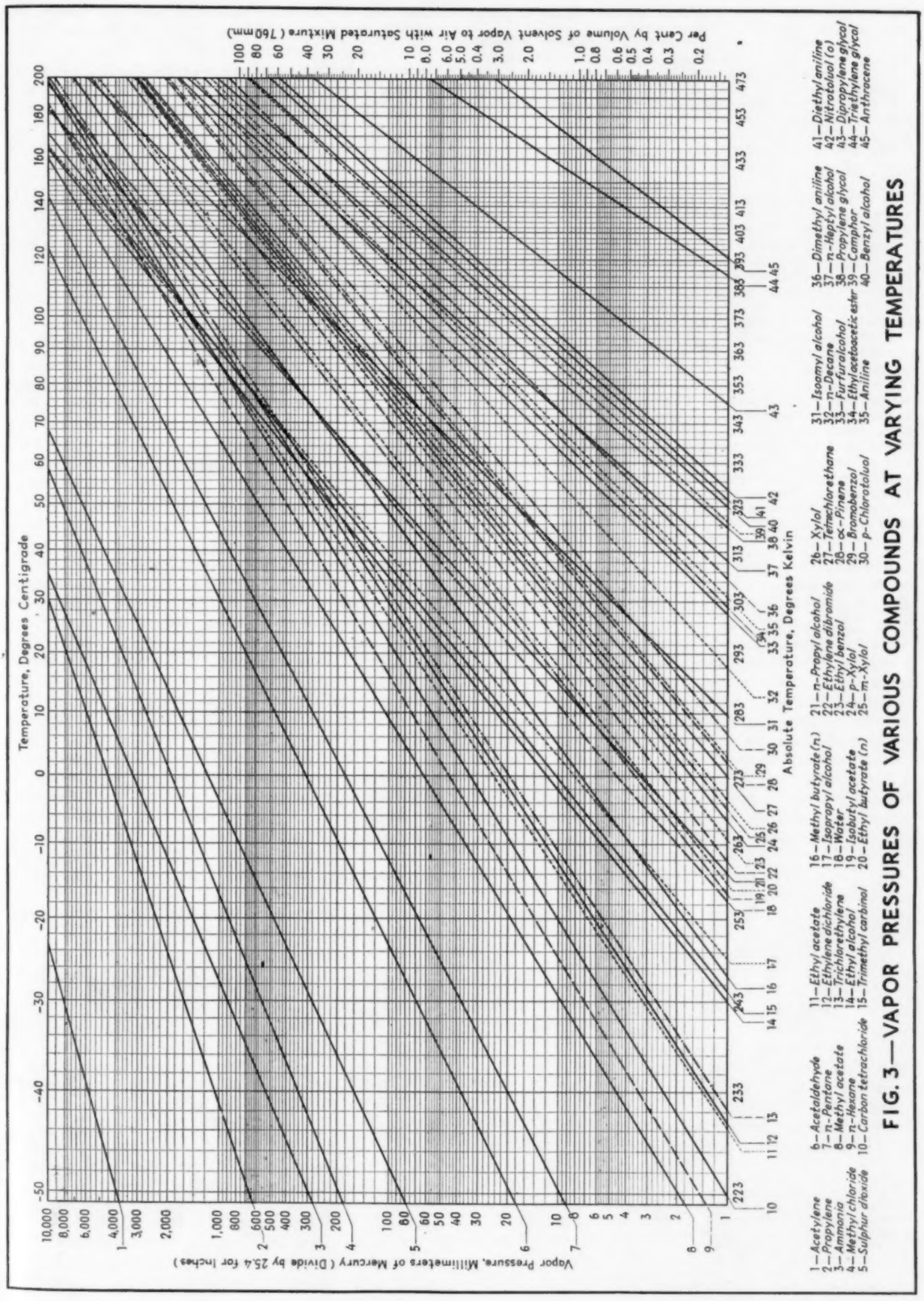


FIG. 3—VAPOR PRESSURES OF VARIOUS COMPOUNDS AT VARYING TEMPERATURES

the exit gas mixture may approach too close to the explosive range of the solvent for safe operation.

3. A considerable space requirement, and difficulty in securing a gas-tight system, are disadvantages of this method.

4. Cooling coil systems are difficult and sometimes almost impossible to clean.

5. Cost of installation and operation is usually relatively high.

On the other hand, the atomizing spray chamber has the following inherent advantages:

1. The rate of heat transfer between the solvent-gas mixture and the spray liquor is relatively high because a tremendous and incalculable amount of cooling surface in the form of atomized liquid is intimately in contact with every part of the gas mixture. The spray liquor can be cooled either in an external cooler or by a refrigerated coil within the spray chamber. In either case a high mass velocity obtains, both within and outside the coil, a high heat transfer rate is secured and only relatively little cooling surface is needed.

2. Uniform treatment of the gas mixture can always be secured and the necessary automatic control regulates the operation from both the recovery and the safety standpoints. This follows from the fact that in a given installation, the leaving gas temperature and consequently the percentage of solvent vapor remaining in it are dependent solely on the spray liquor temperature.

3. Since a cylindrical spray chamber can readily be used in this process, there is no difficulty in securing gas-tightness.

4. Such a system is easily accessible for cleaning since the spray chamber contains only the spray nozzles and their piping. The separate entrainment eliminator at the exit of the spray chamber can be constructed with removable blades.

5. The spray system is cheaper and easier to install.

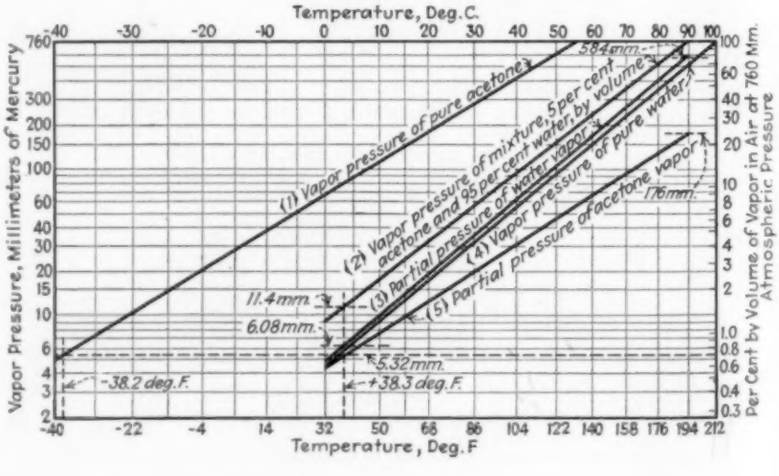
There are two types of process than can be employed in solvent recovery by the spray chamber method. One is a straight refrigeration process in which the spray liquor is identical with the solvent to be condensed, while the other is a combination process making use of both refrigeration and absorption. In the latter case the spray liquor is a mixture of condensed solvent with a liquid miscible in it which can serve as an absorbent for the solvent. An excellent example is the use of a mixture of water and acetone as spray liquor for the recovery of acetone vapor. In the first type of process a low enough spray liquor temperature must be used to reduce the vapor content of the gas stream to the desired point entirely through the lowering of the vapor pressure by reduced temperature. In the second type of process, use of a miscible material in the spray liquor, which has a lower vapor pressure at the temperature of operation than the solvent, permits operation at a considerably higher temperature owing to the absorption effect.

In Figs. 2 and 3* the vapor pressures of a large number of materials, many of which are useful solvents, have been plotted against temperature. Through the use of a plot of the logarithms of the vapor pressures, against a temperature scale which is approximately in proportion to the reciprocals of the absolute temperatures, all of the vapor pressure lines are straight, except that a point of angularity change occurs wherever one of the lines passes through the fusion point within the bounds of the chart. It appears that all volatile liquids plot straight on such a chart, as will the vapor pressures of mixed miscible liquids. Note that a scale is given at the right side of each of the charts giving the percentage by volume of any vapor mixed with air at atmospheric pressure (760 mm.). Thus, for example, when the partial pressure of a vapor such as acetone is 5.32 mm., the content of acetone in a vapor-air mixture at 760 mm. is 0.7 per cent. In the case of acetone, this vapor pressure will be seen to correspond to a saturation temperature of —39 deg. C.

A primary consideration in determining the operating conditions of a spray chamber solvent recovery system is the range in which the solvent forms explosive mixtures with air. Safety requires that the complete operation be carried out at concentrations below the lower explosive limit. Although this means the handling of a large amount of gas mixture, it tends to improve the efficiency of recovery since leakage losses are directly proportional to the richness of the mixture. On the other hand, operation at concentrations above the upper explosive limit is impractical and hazardous, first, because leakage tends to bring the mixture within the explosive range; and second, because, when shut down occurs, in starting up again it is necessary to pass through the entire explosive range before the safe range can be reached.

When the spray liquor is identical with the condensed solvent vapor, through the use of Fig. 2 or 3 it is possible immediately to determine what saturation temperature must be maintained to reduce the vapor content of the circulating gas mixture to whatever percentage may be necessary. However, when other than a material identical with that to be recovered is sprayed, an entirely different condition exists and it is necessary to secure data permitting the plotting of the vapor pressure-temperature curve of the spray liquor (and the partial pressures of its ingredients) throughout the entire operating temperature range (as has been done in Fig. 4 in the case of an acetone-water mixture). If the solvent to be recovered is the only flammable ingredient of the circulating gas mixture, then explosion data must be secured covering its range of explosive mixtures with air, particularly the lower explosive limit. If other of the

Fig. 4—Vapor pressure plot of 95 per cent water—5 per cent acetone mixture and its components


Temperature, Deg.C.
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
Vapor Pressure, Millimeters of Mercury
760 300 200 150 100 60 40 30 20 15 10 6 4 3 2
Per Cent by Volume of Vapor in Air at 760 Mm. Atmospheric Pressure
100 60 40 30 20 10 8 6 4 3 2 1.0 0.8 0.6 0.4 0.3
(1) Vapor pressure of pure acetone
(2) Vapor pressure of mixture, 5 per cent acetone and 95 per cent water, by volume
(3) Partial pressure of water vapor
(4) Vapor pressure of pure water
(5) Partial pressure of acetone vapor
584mm.
176mm.
11.4mm.
6.08mm.
5.32mm.
-38.2 deg.F.
+38.3 deg.F.
-40 -22 -4 14 32 50 68 86 104 122 140 158 176 194 212
Temperature, Deg.F

* Editor's Note: A drafting error in our redrawing of Mr. Bulkeley's Figs. 2 and 3, discovered too late to permit a second redrawing, makes the portion of the logarithmic scale from 4,000 to 8,000 mm. misleading. Note that the divisions are shown 400 mm. apart, the "ticks" indicating the correct location of 5,000 and 7,000 mm.

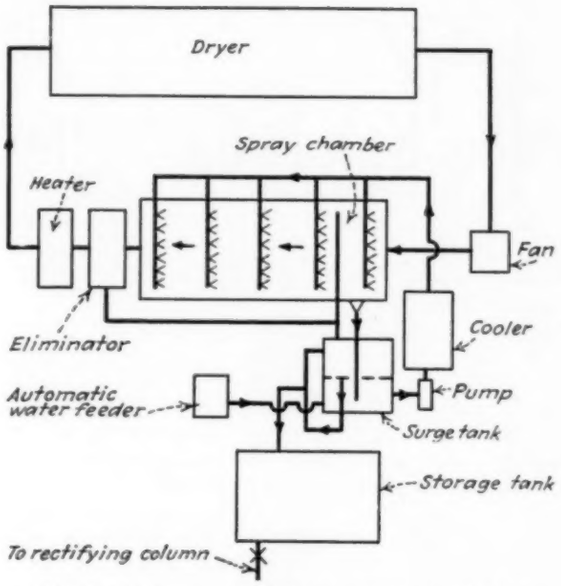


Fig. 5—Diagrammatic sketch of spray atomization recovery unit

ingredients of the spray liquor are also flammable, the explosive range of the mixed vapor must be determined.

With a mixed spray liquor, such as acetone and water, when the diluent of the solvent (water in this case) is non-flammable, it is necessary only to know the vapor concentration of the flammable ingredient. The quantity of inert vapor in the mixture appears to have little or no effect on the explosive range of the flammable vapor. When, however, an inert, non-condensing carrier gas is used instead of air in the circulating gas system, there is no explosive range and operation can safely be conducted as desired. But since such a system is rarely worthwhile owing to other disadvantages, it will not be discussed further.

In Fig. 5 is a diagrammatic sketch suggesting how a solvent recovery system, employing either the pure solvent or a mixed solvent for the spray liquor, might be set up. The sketch, it should be emphasized, is neither to scale nor does it indicate the proper number of sprays. The gas mixture is continuously circulated between the dryer, or other equipment where the solvent is vaporized, and a spray chamber where a part of the solvent is condensed. Spray liquor circulates continuously through the sprays, to a surge tank, through a pump and cooler, and back to the sprays. As solvent condenses, an equivalent quantity overflows to a storage tank where it is held prior to rectification. In the sketch an automatic water feeder is also shown, to be used in case the spray liquor is a mixture of the condensed solvent with water. Although it will generally be possible to enclose the system quite completely, a certain amount of in- and ex-filtration cannot be avoided and more or less atmospheric moisture will be condensed with the solvent unless the vapor pressure of the atmospheric moisture is less than that of the water in the spray liquor. Since many solvents are completely miscible with water and since, as has been pointed out, a mixed spray liquor of proper composition will permit operation at higher temperature, it is clear that there should be a wide field of application for mixed spray liquor recovery systems. A further advantage is that solvents mixed with water are readily rectified, while water, unlike other liquid absorbents, has no commercial value and can be discarded in the cheapest available manner.

In the spray atomization method the set up is essentially similar to an ordinary spray chamber, and yet the construction and performance must be quite different. Instead of the exit gas mixture being within ½ deg. C. of the *leaving* spray liquor, it is necessary that it be within ½ deg. of the *entering* spray liquor at the nozzles. Completely effective means must be used to prevent clogging of the spray nozzles, a considerably lower face velocity through the chamber is required, and more effective entrainment eliminators must be used. Since safety is imperative, depending solely on the amount of solvent in the exit gas, and hence on the exit gas temperature, it follows that the saturation temperature must be controlled within the narrowest possible limits, say, not to exceed ½ deg. C. Although variations in the heat load may affect the leaving spray liquor temperature, they must not appreciably affect the leaving saturation temperature. Although normally these requirements would call for an excessive quantity of spray liquor, a properly designed spray chamber will permit the spray liquor to leave at 4–5 deg. C. higher than its entering temperature, while as much as 14–20 B.t.u. can be extracted per pound of the circulating gas mixture.

As an example of a recovery process using a mixed spray liquor, an acetone-water system for acetone vapor has been mentioned. In Fig. 4 are plotted lines for vapor pressures of pure acetone, pure water, a mixture of 95 per cent water and 5 per cent acetone, and the partial pressures of water and acetone in the mixture. It is an interesting fact that the lines for the first three of these factors appear to intersect at a common point considerably below the critical temperature of water. Since the lower explosive limit for acetone vapor in air is 2.8 per cent acetone by volume, for safety the circulating gas entering the spray chamber should contain not more than 1.4 per cent acetone. It follows that the air in circulation should be sufficient so that the acetone vaporized in the drying process will not exceed 0.7 per cent and that the exit gas mixture from the spray chamber will not contain more than 0.7 per cent acetone, corresponding to a partial pressure of 5.32 mm.

From Fig. 4 it is clear that when the vapor pressure of acetone is 5.32 mm. the saturation temperature in the case of the pure vapor must be —39 deg. C. (—38.2 deg. F.). With a 5 deg. differential for the refrigerant, in both the spray type using the pure solvent and in the cooling coiling type, a refrigerant temperature of —44 deg. C. would be necessary. On the other hand, with a spray liquor of 95 per cent water and 5 per cent acetone, and a partial pressure of acetone vapor of 5.32 mm. (0.7 per cent in air at 760 mm.), a saturation temperature of +3.5 deg. C. (+38.3 deg. F.) is all that is required, which is well above the freezing point of water.

Similar results can be obtained with other spray mixtures where the diluent is miscible with the solvent, non-flammable, and has an essentially lower vapor pressure at the operating temperature. Such a recovery system, properly installed and operated, will permit well over 95 per cent recovery of the recoverable solvent.

Although spray recovery systems are not new, they have been described at some length because they seem to be suitable for much more extensive application than has heretofore been made. They are suitable for use in almost all cases where recirculation in a closed system is possible, and because of the recirculation and continuous rewashing, assure almost complete freedom from foreign particles and a cleaner exit gas mixture than can be secured by other means.

In conclusion the author wishes to acknowledge the valued assistance of George V. Deverall, of Buffalo, who painstakingly determined the vapor pressure data for the acetone-water mixture plotted in Fig. 4. Mr. Deverall plans to continue this line of investigation with other mixtures to determine whether a general law relating to the vapor pressures of mixtures of miscible volatile liquids can be formulated.

Chemical Pioneering in the Kanawha Valley

By J. N. COMPTON and E. T. CRAWFORD, JR.

CARBIDE & CARBON CHEMICALS CORP.,
SOUTH CHARLESTON, W. VA.

CHEMICAL INDUSTRY in the Charleston district, is practically confined to the narrow river valley of the Kanawha (more properly called the Great Kanawha, to distinguish it from the Little Kanawha, a parallel stream to the north) located on either side of the river along some 53 miles of its course, from its source at Gauley Bridge to Nitro about 44 miles above the mouth of the river at Point Pleasant and lying in the contiguous counties, Fayette, Kanawha and Putnam.

The principal natural resource of the district, and of West Virginia as a state, is the enormous deposit of high grade bituminous coal underlying most of the area to the west of the mountains. In the Kanawha field alone, according to estimates of the Geological Survey, the coal reserve is over 24 billion tons, in five seams of commercial importance, which at present rates of depletion will be exhausted in about thirteen centuries, practically justifying the statement made in 1815 by one of the pioneer salt manufacturers, "Fire-wood in the course of time must become scarce or difficult to get, but stone coal may be used instead of it, and of this our stock is inexhaustible."

Excellent byproduct coking coals are produced from two seams, furnishing an important raw material for the manufacture of synthetic ammonia and methanol.

Second in importance among natural resources of the state is natural gas, which is found practically throughout a broad belt between the mountains and the Ohio River, extending from the Pennsylvania line on the northeast to the Kentucky line on the southwest, and including the entire Charleston industrial district. The first gas well was drilled in 1815 within the present city limits of Charleston. Since 1885 the state has produced about nine billion thousand cubic feet of gas, of which perhaps three-quarters has been utilized and one-quarter wasted. The gas actually utilized is estimated to have had a value of more than $1,500,000,000 at its point of consumption. About three years ago it was estimated that the natural gas reserve in the state was probably about three billion thousand cubic feet, or roughly 50 per cent of the previous useful production, and sufficient to last about 30 years at present rates of depletion. The recent discovery of new reserves in deeper sands probably makes this estimate of reserves extremely conservative.

A certain amount of oil is obtained practically throughout the gas field, and there are several centers of production in the Charleston district which have justified the maintenance of two oil refineries, that of the Pure Oil Co. at Cabin Creek and of the Elk Refining Co. on the Elk River about 12 miles above Charleston. The district is also served by transcontinental pipe lines with delivery by the Eureka Pipe Line Co., which not only pick up local oil, but also deliver mid-continent oil.

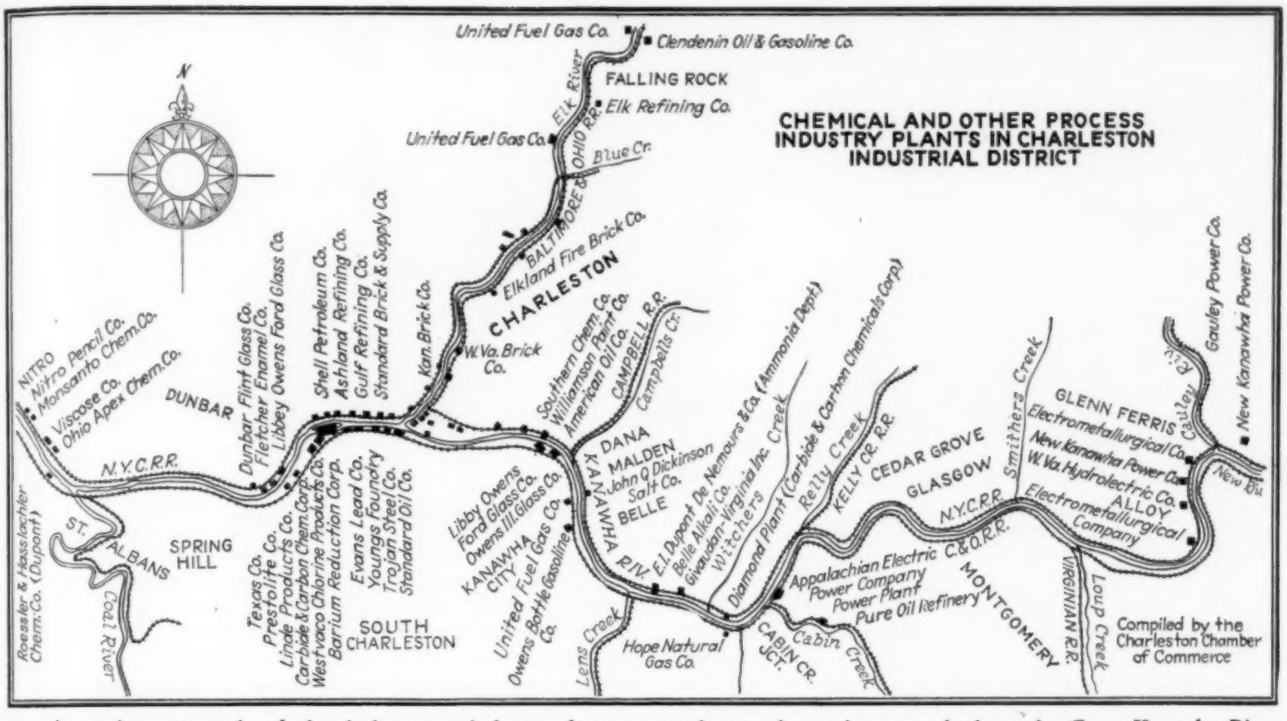
An important part of the activities of the larger gas companies is the operation of natural gasoline plants in connection with their compressor stations, which remove natural gasoline by compression, by absorption in activated carbon, or absorption in mineral oil. It is of interest to note that the chemical industry in coming into the district contributed to the natural gasoline industry one of its most notable technical advances—the use of the stabilizer, and the conception of stabilized gasoline, both of which originated in a chemical plant in Kanawha County.

Following far behind coal, gas and oil in importance as natural resources, but of interest to the chemical industry, is the occurrence of deposits of entrapped salt brine, of about 8 per cent concentration lying at a depth of about 900 to 1200 ft. No solid salt is found and the brine is apparently concentrated ocean water in porous strata not reached by surface drainage.

The important pioneer industrial chemical operation of the region was the concentration of brine obtained from natural salt springs, starting as early as 1797, followed by operation of the first drilled brine well in 1808. Rapid growth followed, until more than 60 separately owned salt furnaces were in operation. Production reached its peak between 1845 and 1853, when the region furnished most of the salt used in the west; declined abruptly because of competitive operations along the Ohio after 1853; sank to a low ebb during the Civil War period, recovered gradually until 1870 and then went into its final decline. At present only one of the original plants remains, that of J. Q. Dickinson & Co. at Malden which has operated continuously, except for interruptions from floods, for 106 years since 1832, making grainer salt for the agricultural trade.

The resourceful pioneer industrialists of the salt industry have left a creditable record of accomplishment, commercial as well as technical. In 1808 they were responsible for the first recorded drilling in America through rock by means of percussion tools and in following years developed their own tools and methods for deep well drilling, sinking an exploration hole 1700 feet deep in 1845. Their tools, casings, packing methods and drilling technique were used by Colonel Drake in the petroleum discovery well at Titusville, Pa., in 1859, and were the starting point for the development of all modern oil drilling methods.

Based on a paper of the same title presented before the American Institute of Chemical Engineers at White Sulphur Springs, West Virginia Meeting, May 9-11, 1938.



A continuous parade of chemical process industry plants greets the traveler as he proceeds down the Great Kanawha River Valley from Glen Ferris through Charleston to Nitro, W. Va., a distance of some 53 miles in three counties

Bromine was identified in Kanawha brine in 1830 and in 1868 methods for its production were worked out, the inventor becoming the world's most important producer of bromine in 1870. The Dickinson salt works, sole survivor of the industry, has continued to the present time to produce bromine and bromides.

Of especial interest technically is the pioneer use in 1833 of the principle of double-effect evaporation some eight years prior to other known practical applications of the principle. In the Kanawha district, steam taken from closed concentrating pans was used for indirect heating of open "grainer pans" in which salt was crystallized, the saving of fuel being of less importance than the marked improvement in quality of the product.

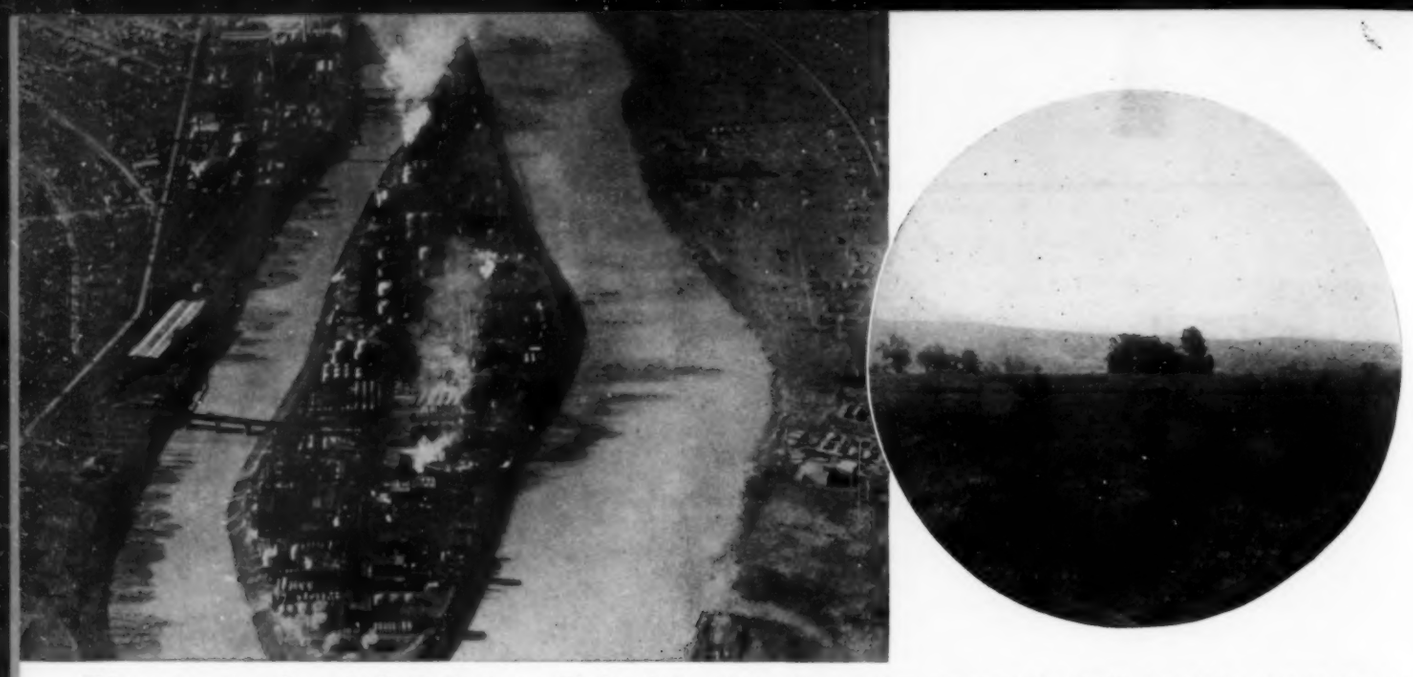
Transferring attention from the past to the present chemical industry, an idea of its components may be gained by traveling in imagination down the river from Gauley Bridge to Nitro. (See accompanying map.) On the New River, a few miles above Gauley Bridge is the Hawks Nest Dam of the Electro Metallurgical Co., a unit of Union Carbide and Carbon Corp., built to furnish electric power for its own use at Alloy. It has an installed capacity of 140,000 h.p. A power development at Hawks Nest was conceived some 30 years ago by Major J. T. Morehead, who was associated with Willson in the original discovery of calcium carbide, and continued pioneer work in the application of the electric furnace, especially to the manufacture of alloys, with the Willson Aluminum Co. after the Union Carbide Co. had been formed to take over rights in the United States for the manufacture of calcium carbide. The Willson Aluminum Co. had operated a small hydro-electric plant at Kanawha Falls from 1900 until 1906, when the interests of the company were merged with similar developments of the Union Carbide Co. to form the Electro Metallurgical Co. The pioneer electric furnace alloy plant at Glen Ferris was further developed and continued in operation, but the extensive property and riparian rights for the larger power development were not put into use until about 25 years later.

At present the small plant at Glen Ferris and the much larger plant at Alloy both conduct electric furnace operations for the manufacture of ferro-chrome, ferro manganese, ferro-silicon and other alloys. Supplementing the hydro-electric power from the Hawks Nest-Gauley Bridge development, the Alloy plant also has a steam power installation of 70,000 h.p. capacity, which is somewhat notable in that coal from the company's mining operations about two miles back in the hills is conveyed directly to the elevated coal-bunkers at the power house by an overhead gravity bucket conveyor.

At Diamond, some 14 miles above Charleston, is one of the several plants of the Carbide and Carbon Chemicals Corp. for separating from natural gas certain hydrocarbons which are marketed as such or used as raw materials in their plant at South Charleston.

At Belle, some 12 miles above Charleston, the oldest establishment manufacturing chemicals is the electrolytic plant of the Belle Alkali Co., adjoining the abandoned site of the Sharples Solvents Co.

The dominant plant at Belle is that of the Ammonia Department of E. I. duPont de Nemours and Co., which ranks as one of the two principal industrial establishments manufacturing chemicals in this district. The duPont plant occupies a tract extending along the river for a length of about 3,900 feet, and approximately 1,200 feet wide. It is an impressive modern chemical works, carefully laid out with ample room for expansion, and with long range plans for development. It was started in 1925 as Lazote, Inc., originally a partnership between the duPont company and French interests controlling the Claude process for the manufacture of synthetic ammonia



Thirty years ago and now in South Charleston, W. Va. Industrial development has converted the fertile farmlands of 1907 into the thriving center of many millions of dollars worth of industrial enterprise, an exemplification of the growth of chemical industry

from nitrogen and hydrogen. The original process and some of the equipment was imported from France, but extensively developed and modified by the duPont company, which subsequently incorporated features of the Casale process previously operated by the Niagara Ammonia Co. at Niagara Falls. In 1929 the French interests were bought out and the plant became the duPont Ammonia Corp., which name was subsequently changed to the Ammonia Department of E. I. duPont de Nemours and Co.

The principal reason for location in this district lay in the abundance of cheap coal of suitable quality, the most important raw material entering the plant. With the success attained in its operations for the manufacture of ammonia, and its important contributions to technical improvement and development of the original processes, high pressure catalytic technique has been extended to the manufacture of synthetic methanol, of which the plant is the single most important producer in the country, and to a wide variety of other products including isobutanol, urea, and methyl methacrylate. In addition, prospects are excellent for further application of the process to the synthesis of acetic acid, and numerous other important products. The plant includes a battery of modern byproduct coke ovens, and an extensive installation for the generation of water-gas, in addition to the special equipment for high pressure synthesis and for refining the products.

A short distance below Belle, on the river just above the old town of Malden is the salt plant of J. Q. Dickinson and Co., established in 1832, the sole survivor of the Kanawha salt industry, said to have maintained continuous profitable operation since its establishment, using the original processes and types of equipment, parts of the latter, principally wooden vats preserved by salt impregnation, having been in use for over a century. Aside from the salt, the other principal products are bromine and bromides recovered from its own brines and from concentrated bitterns shipped in from Ohio Valley salt plants.

Approaching the city of Charleston, the plants of the Libbey-Owens-Ford Glass Co. and the Owens-Illinois Glass Co. are visible from a distance across the river. The former manufactures plate glass by the Colburn continuous sheet process, and the latter is one of the important producers of machine-blown bottles. Proceeding through the city of Charleston, which lies on both banks of the Kanawha River at its junction with the Elk River, the plant of the Evans Lead Co. is passed just before reaching South Charleston. This organization is a subsidiary of the National Lead Co., and manufactures red lead, litharge, battery oxides and pigments.

The original bottom land now constituting the site of South Charleston (see above), which is across the river and downstream from the business center of Charleston, was acquired in 1908 by a development company, which built a connecting bridge with the city and interested several small organizations in locating there. The first chemical plant was that of the Rollin Chemical Co. founded in 1913 to manufacture barium oxide and the barium salts, and reorganized under new management as the Barium Reduction Corp. in 1923. This organization uses as its principal raw material, barytes, mined in Tennessee, and in addition to the commercial barium compounds, produces sodium sulphide, ammonium sulphide, and hydrogen sulphide.

Toward the close of the War, the Rollin organization acquired the adjoining property of the Ohio Tool Co., and built a new plant for the manufacture of chlorine, carbon tetrachloride, and monochlorbenzol. This project was dropped immediately after the Armistice, and the property remained idle until it was taken over in 1924, by the first commercial plant of Carbide and Carbon Chemicals Corp. The present plant of the latter organization, which ranks with the Belle works of the duPont company in local importance in the chemical industry, is of somewhat more than ordinary interest to the present discussion, because it is almost entirely a development within Kanawha County, West Virginia, from the traditional test tube to tank car. Its sponsors started by acquiring the small gasoline plant of the Clendenin Gasoline Co. on the Elk River about 20 miles above Charleston and transferring all experimental work to this plant. Shortly afterward, incorporation of the Carbide and Carbon Chemicals Corp. was announced, in July, 1920. For the five years following, its activities in chemical manufacturing were confined to the operation of small-scale development plants at Clendenin, in which

its processes were developed and which furnished sufficient quantities of new products for sales development. In 1925, commercial operations were undertaken on a large scale, on the property comprising about 11 acres of ground and the buildings of the original Rollin chlorine products plant.

The original technical foundation for this development was laid prior to the formation of Union Carbide and Carbon Corp., by the separate technical developments of three companies, which became units of that corporation at the time of its formation in 1917. The basic chemical research work and the broad general idea of an industry for the manufacture of synthetic aliphatic chemicals, using as a basis the simpler unsaturated hydrocarbons, originated with Dr. George O. Curme, Jr., and the fundamental research work was carried out by Dr. Curme and his associates at the Mellon Institute between 1914 and 1919.

From its modest initial commercial operations in 1925, the South Charleston plant has experienced rapid growth to a position of commanding importance in the industry. It has expanded practically continuously for 13 years, in which it has occupied Blaine Island in the Kanawha River (see cut) and all of the available ground on the mainland opposite the island, until it now occupies a connected area of 160 acres, extending along the river for more than a mile.

The importance of this development, and more especially the character of the chemical engineering work which was essential to it, were recognized as early as 1933 by its receiving the first *Chem. & Met.* Award for Chemical Engineering Achievement. (See *Chem. & Met.*, Nov. 1933, pp. 563–570.) Since the entire development has been carried out in what might be called the modern era of American chemical engineering, there has been unusual opportunity for the chemical engineer to be of service.

Practically the sole reason for the original location of this industry in the Charleston district lies in the availability there of adequate supplies of hydrocarbon raw materials in the form of natural gas, petroleum, and coal, in a location convenient for transportation of finished products to the principal centers of industry in the country. Products are confined to aliphatic organic chemicals synthesized principally from the simpler hydrocarbons, which in turn are obtained from natural gas from crude oil or from coal. All three sources of material are utilized at South Charleston. In the earlier stages of operation, light hydrocarbon raw materials were delivered by special tank cars, but at present the principal means of transportation of these materials are by cross-country pipe lines. Crude oil is delivered from the mid-continent field to the plant by a common-carrier pipe line.

Aside from its impressive size and complexity, the plant is notable as including the first important commercial installation for the manufacture of synthetic ethanol, and pioneer commercial plants making ethylene glycol, acetone, synthetic butanol, acetic anhydride, and a long list of related compounds and derivatives. The principal research laboratories, engineering, and construction activities of the Chemicals Corp. are also located at South Charleston.

Adjoining is the plant of Westvaco Chlorine Products Corp., formed in 1927 principally to supply the rapidly growing usage of chlorine by Carbide and Carbon, with which its subsequent growth has kept pace until the present producing capacity is approximately ten times that of its original predecessor company, the Warner-Klipstein Co. The latter was established in 1916, as a partnership between the Warner and Klipstein interests and H. R. Nelson, inventor of the Nelson cell. The original organization had expected to subject natural brine to electrolysis without concentration, but this was found to be impractical and the industry which located in this district partly because of the availability of salt, actually found it expedient to import rock salt from New York and Michigan rather than to pump, purify and concentrate Kanawha brine, although it carried out the latter operations on a limited scale. With its larger-scale operations of recent years the present company has set up an extensive system of brine wells and gathering lines scattered over an area of five miles on either side of the plant. It has added an extensive steam plant, generating its own byproduct electric power, and supplying exhaust steam for brine as well as for caustic soda concentration. The salt-steam-power balance is maintained by the continued importation of rock salt from Michigan.

Another general center of the chemical industry of the district is at Nitro, some 13 miles below Charleston, almost opposite the old town of St. Albans, which was the site of a plant of Roessler and Hasslacher Chemical Co., established to manufacture products by the chlorination of methane, but since abandoned. Nitro was the site of the enormous wartime government project, Explosives Plant "C," comprising a complete self-contained explosives plant and an entire town for housing its employees. It represents an expenditure of more than $80,000,000, and is now completely liquidated, with practically all of the original equipment and manufacturing buildings destroyed. This excellent plant site and its utilities are now utilized by several industries, the most important of which is a plant of the Viscose Co. After the War, this company took over the enormous stock of cotton intended for nitrating, and some of the handling, storage, and warehousing equipment. It operated for some years at Nitro to manufacture purified cotton pulp for shipment to rayon plants, but more recently the property has been utilized for a new operation making viscose process cut staple yarn, using wood pulp as raw material.

Also located at Nitro is the plant of Rubber Service Laboratories, now a subsidiary of Monsanto Chemical Co., but originally an independent organization established at Nitro for the manufacture of rubber accelerators and other compounds. Another is the plant of the Ohio-Apex Chemical Co. which produces chemical specialties. This company was organized in 1934, to succeed the Kavalco Products, Inc., which had been engaged in this business since 1929.

This paper has traced the growth of chemical industry in the Kanawha Valley. It is of interest that practically all of this development has occurred since 1917. With tremendous reserves of coal and gas, favorable location in regard to markets, adequate rail and water transportation facilities, and a plentiful supply of excellent labor, there would seem to be no economic reason for believing that the phenomenal growth of this district in the past twenty years should not be equalled or exceeded in the future. The traditions of the original pioneers in the local salt products and coal oil industries are truly being carried on by the equally pioneering synthetic chemical industry.

Chemical Engineers Invade W. Va. for 30th Birthday Meeting

EDITORIAL STAFF REPORT

FOR THE FIRST TIME in its history the American Institute of Chemical Engineers officially invaded the State of West Virginia to appraise the rich resources that have led to the phenomenal development of its chemical and process industries. More than 300 members and guests registered at the Greenbrier, in White Sulphur Springs, for the 30th semi-annual meeting, May 9–11. Plant inspection trips through the rayon and paper mills at Covington, Va. and an all-day excursion through the Kanawha Valley to Charleston, with visits to a half-dozen of its chemical industries, provided especially profitable features of the program. Technical sessions under the chairmanship of President Fred C. Zeisberg and Vice-President Webster N. Jones, included 18 papers of industrial and professional interest.

Appropriately, the convention started off with a cheerful message of welcome by Rodolphus K. Turner, resourceful chemical engineer of Carbide & Carbon Chemicals Corp., who not only served as active head of the local committee, but effectively represented his colleagues, J. N. Compton and E. T. Crawford, in presenting their comprehensive paper on the development of chemical industries in the Great Kanawha Valley (see p. 306 this issue).

Most professional interest undoubtedly centered in the remarkable paper on "The Development of Chemical Engineering Education in the United States", which Prof. Albert B. Newman presented as Chairman of the A.I.Ch.E. Committees on Chemical Engineering Education. This able summary encompassed the entire history of the profession, including that of the present system and procedure of accrediting universities and colleges in which chemical engineering is taught. Much of the discussion evoked by this paper centered around the recognized necessity for better ability on the part of the young graduate to express himself clearly and adequately in oral or written reports. Dr. Charles M. A. Stine, vice-president of du Pont, injected the startling thought that a modern chemical engineering course is perhaps the best possible basis on which to build almost any type of business career.

Dr. Harry A. Curtis brought the first session to a close with his paper on the full-scale production of the new highly concentrated fertilizer, calcium metaphosphate. This had been prepared in collaboration with his colleagues in the chemical engineering department of the Tennessee Valley Authority (see p. 318).

At the second technical session, Charles F. Bonilla of Johns Hopkins University discussed the interpretation of constant rate filtration data, developing mathematical formulas based on the equations of Gilliland and Ruth. From an experimental and theoretical viewpoint, constant rate runs prove convenient when only rough values are desired or when time or data are lacking. In such cases it is possible to determine all of the filtration equation values from a single run instead of a minimum of two runs as are required at constant pressures.

E. L. McMillen and H. A. Webber of Iowa State College, dealt with the accuracy of predicting plant operations from filtration test data. Heretofore predictions based on such data have not been considered entirely reliable. In the Iowa investigation small-scale constant pressure test filtration data have been converted into constants representing filter cake and cloth resistances by utilizing the new filtration equations of Ruth. This knowledge of cake and cloth resistance is used to predict capacities of plate-and-frame and rotary vacuum filters under various conditions of temperature, sludge concentration and pressure (or vacuum) of filtration.

Then followed two papers on catalysis. Dr. Max Jakob of the Research Foundation, Armour Institute of Technology, described a new experimental technique for determining the temperature of the outside surface of a catalyst and showed that the so-called thermal effect observed by several authors and used for comparing metals in their catalytic efficiency is exactly the difference between the temperature of reaction and the mean temperature in the catalytic vessel.

The second paper, by Hermann W. Mahr of the Organic Chemicals Department of the du Pont company, dealt with the economic life and cost of catalysis in industrial operations. It is published elsewhere in this issue.

Prof. H. F. Johnstone of the University of Illinois Experimental Station and Dr. R. V. Kleinschmidt of Arthur D. Little, Inc., were joint authors of a paper on "The Absorption of Gases in Wet Cyclone Scrubbers". This paper, which describes the performance of two wet cyclone dust washers of the Pease-Anthony type used as gas absorbers, will be published in an early issue of *Chem. & Met.*

Two papers from J. R. Withrow's department of chemical engineering at Ohio State University opened the technical session on May 11. The first of these, presented by L. K. Herndon, was entitled "Mitigation of Trade Waste Pollution in West Virginia". It showed that following the establishment of the State Water Commission, cooperative work with industries in the state has resulted in the installation of effective tannery waste disposal systems, phenol recovery units at byproduct coke ovens, and material reduction of waste from paper mills, oil refineries and chemical plants.

Prof. J. H. Koffolt demonstrated a complete and ingenious set of charts for the control of factory solutions in rayon manufacture. He showed how the factory

solution control problem in viscose rayon manufacture which may involve from 3 to 20 variables, may be tremendously simplified by the use of graphical methods, especially nomographic charts. An article describing the methods used in preparing these charts will appear in a subsequent issue of *Chem. & Met.*

Dr. Lawrence W. Bass and E. R. Mease of Mellon Institute were joint authors of a paper on "The Application of the Materials-Balance to the Cost Control of Manufacturing Operations". The practical application of direct or derived weights of materials, together with the usual control laboratory data, can form the basis of an extremely useful system of "chemical bookkeeping". Dr. Bass cited examples of the practical use made of this procedure in cotton spinning, paper, rubber, and dairy industries.

Food processing, according to Dr. Laurence V. Burton, editor of *Food Industries*, differs but little from chemical processing. It demands chemical engineering training *plus* knowledge of biological chemistry, bacteriology and sanitation. As he outlined it in his paper entitled "Adapting the Chemical Engineer to Food Industries", a whole new profession of food engineering is beginning to develop in this country.

Smith D. Turner and A. C. Rubey of Humble Oil & Refining Co., Houston, Tex., were authors of a paper describing the new plant at Baytown, Tex., for utilization, by conversion to polymer gasoline, of light hydrocarbons, formerly useful only as fuel gas or wasted to the atmosphere. The principal units of the equipment included (a) a 300-mile pipe-line for the transportation of about 15,000 bbl. per day of light hydrocarbons to Baytown; (b) a superfractionation plant for rectification of this mixture, including the separation of isomers with a high degree of purity; (c) a thermal polymerization plant to charge about 9,000 bbl. per day of butanes and produce about 3,500 bbl. per day of polymer gasoline and (d) pressure storage facilities for pipeline stream volatile products.

At the final technical session on May 11, Dr. Webster N. Jones, vice president of the Institute, first introduced C. C. Furnas of Yale, who, in collaboration with F. Bellinger of the Hercules Powder Co., had prepared a paper on "Operating Characteristics of Packed Columns". Data of pressure drop, liquid hold-up and coefficients of absorption of carbon dioxide in sodium carbonate solutions in a 12-in. diameter tower were presented for three types of packing: ⅜-in. raschig rings, 1-in. raschig rings and 1-in. Berl saddles. A new method of correlation was developed whereby the performance of all three packings is presented as a single function of liquid velocity and liquid hold-up.

E. H. Smoker of the research department of the United Gas Improvement Co., Philadelphia, described a method for the determination of plates in fractionating columns. He has developed an analytic method which was claimed to have a number of advantages over the usual graphic method of McCabe and Thiele.

Thermodynamics came in for attention from two directions. Prof. George Granger Brown of the University of Michigan, presented his "Introduction of Chemical Engineering Thermodynamics" to show its practical application to industrial problems. Too often the subject is developed in the classical manner by the consideration of isolated systems. Professor Brown pointed out that the engineer is usually forced to consider non-isolated systems and therefore a general development based on consideration of the energy transformation accompanying a process has been attempted.

The second paper, by Prof. Barnett F. Dodge of Yale University, was intended as a quick review of the application of thermodynamics to chemical reactions from the viewpoint of the chemical engineer.

"Engineering Utility of the Second Law Principle" by H. C. Weber and Robert York, Jr., of Massachusetts Institute of Technology, showed how the laws of conservation of matter and conservation of energy constitute the foundation for calculations generally grouped under the head of stoichiometry. The second law of thermodynamics is the foundation for the important division of chemical engineering known as "unit operations."

Pulp and Paper Discussed by Electrochemists

EDITORIAL STAFF REPORT

THE ANNUAL MEETING of the Electrochemical Society was held at Savannah, Ga., April 28–30. Inspection visits to eight of the local process industry plants were made. A large number of unusually important papers were presented at the several technical sessions.

The first technical session covered physical chemistry in the pulp and paper industry. Dr. Charles Carpenter, assistant director of the Herty Foundation presided. The chemistry of bleaching chemical wood pulps was discussed by John D. Rue of the Hooker Electrochemical Co., Niagara Falls. Modern bleaching of chemical wood pulps is stepwise purification of colloidal cellulose. Lignin is removed by chlorination supplemented by some oxidation. Water insoluble chlorinated products are solubilized with caustic soda. Some dyes of natural origin in sulphate pulps are solubilized with caustic soda, while other coloring matter is rendered colorless by oxidation. The action of chlorine is directed toward chlorination or oxidation and its harmful attack on celluloses minimized chiefly by adjustments in the pH and of temperature.

The use of electrolytic chlorine for the manufacture of cellulose was the subject of a paper by Umberto Pomilio of Rome, Italy. The utilization of chlorine in the pulp and paper industry was described, referring especially to bleaching with moist chlorine directly from the electrolytic cells, in comparison with chlorinated water and active oxygen from hypochlorites. The history, origin,

development, and evolution of the Pomilio chlorination of pulp process were briefly outlined, emphasizing the continuity of operation and the interlocking steps in the whole cycle. The process has, as yet, not been introduced into the United States.

The physical chemistry of clay, its particle size, and structure, and colloidal reactions were reviewed briefly in a general way with reference to behavior when used as a paper filler by C. G. Albert of Edgar Bros., Metuchen, N. J.

Louis E. Lovett, consulting engineer of Cleveland, discussed the application of osmosis to the recovery of caustic soda solutions containing hemicellulose in the rayon industry. As he pointed out, this commercial use of osmosis is of great value since, in this country alone the installed dialyzer capacity represents an annual recovery of 90,000,000 lb. of actual caustic soda.

The cost of recovery is very constant. Including all direct and indirect charges covering buildings, equipment, operating expenses, taxes, etc., the cost per pound of recovered soda is between $0.004 and $0.005.

Corrosion problems encountered in the sulphate pulp mill were discussed by James A. Lee, managing editor of *Chemical and Metallurgical Engineering*. The compositions of the several solutions employed are complicated. Some of the digester shells have pitted badly next to the welds. 18-8 chrome-nickel steel is being tried in new shells. Monel and low-carbon steel appear satisfactory for diffusers. For inlets and outlets of digesters, stainless steel, Ni-resist and Monel were recommended. Chrome steels have, likewise, given good service with digester circulating pumps. For bleach liquors, rubber lining is best. Cast iron is most generally used for impeller construction, with Monel metal shafts.

Corrosion characteristics in the distillation of fatty acids was the subject of the paper by Prof. Frank C. Vilbrandt and Lilburn E. Ward, Jr., Department of Chemical Engineering and Engineering Experiment Station, Virginia Polytechnic Institute, Blacksburg, Va. The fatty acids are particularly interesting to the pulp mill engineers at this time because of the recovery of chemicals. Crude fatty acids corroded all alloys and metals to a marked extent, with the exception of stainless steels containing not less than 20 per cent chromium and not less than 9 per cent nickel. The most suitable alloys of the stainless steel group for structural material for fatty acid stills seem to be the iron alloys containing a high chromium and nickel content, or those with a smaller per cent of chromium and nickel but alloyed with molybdenum. The most resistant alloy was an 18-8 chromium-nickel with 3 per cent molybdenum.

Electrowinning and electroplating were the subjects discussed at another session. This meeting was presided over by Dr. E. M. Baker of the University of Michigan. Michel Cymboliste, Neuilly-Paris, France, on the basis of 300 samples examined concluded that a certain analogy exists between the well-known structure of other electrolytically deposited metals and the structure of chromium deposited from chromic acid baths.

Causes of porosity in electrodeposited coatings, especially of nickel on steel were reported by A. W. Hothersall and R. A. F. Hammond, Woolwich, London. Finely divided solid matter in suspension in the solution, foreign matter in the surface of the steel, and a rough condition of the surface were found to be the most important causes of porosity in nickel deposits formed on unpolished steel.

Prof. C. J. Brockman and Prof. John H. Mote of the University of Georgia, were the authors of a report on alkaline plating baths containing organic amines—copper plating from solutions containing ethylenediamine. Several solutions were prepared, containing copper sulphate and ethylenediamine, from which bright and firmly adherent deposits of copper were obtained on iron at temperatures of from 20 deg. C. to 65 deg. C. and current densities ranging from 0.025 amp./sq.in. to 0.20 amp./sq.in.

Professor Brockman and C. P. Tebeau stated that several solutions were prepared containing copper sulphate, monoethanolamine, and sodium oxalate from which bright, firmly adherent deposits of copper were obtained within the temperature range 20–30 deg. C., at current densities of 28.8–108 amp./sq.ft. These solutions do not deposit copper or iron by displacement, resembling the copper cyanide plating bath in this respect.

An electro-washing process, usually comprising a three compartment cell, has been effectively applied to a variety of materials, according to Sakuji Komagata, Tokyo, Japan. The process promises a wide field of application in industry. Detailed experimental results for the electrowashing of the following materials are recorded; vulcanized fiber, pulp for power cable paper and condenser paper, photographic plates and films.

The structure of electrodeposited copper alloys was reported by Walter R. Meyer and Prof. Arthur Phillips of Yale University.

At the technical session dealing with electro-osmosis and galvanic cells, which was presided over by Prof. H. Jermain Creighton of Swarthmore College, Carr E. Curtis of Simonds Worden White Co., Dayton, Ohio, discussed the application of electrophoresis to the dewatering of clay suspensions and of electro-osmosis to steel die lubrication in the stiff-mud process.

The application of electro-osmosis to electrical lubrication is primarily a mechanical problem; as such, the process will doubtless be gradually adopted as ceramic manufacturers become educated to its possibilities and as the need arises. Electrical lubrication has the advantage of requiring little specialized machinery.

Electrophoresis, on the other hand, requires machines and careful control for efficient operation. It is possible that electrochemists and colloid chemists working together could increase this efficiency. It is reported that a large amount of electric power is or soon will be available in the vicinity of the great kaolin beds of our southern states. Such being the case, electrical dewatering deserves careful study in connection with these clays. It is possible that their most highly colloidal portions can be recovered by electrophoresis to form a valuable product.

The results of measurements on the electrophoretic mobilities of different types of colloids in aqueous solutions of varying pH and of ionic strength of about 0.01 were described by Ian Kemp of Birmingham, England.

W. A. Wesley of the International Nickel Co., reported on anode and cathode weight losses in galvanic corrosion. Simple relationships between current flow and the corrosion rates of iron anodes and cathodes have been suggested at different times but are not accepted as fundamentally sound. The results of corrosion tests made with a variety of metals and solutions were examined from a practical point of view and it was found that these relationships are more widely applicable than heretofore believed.

For a news account of the meeting see *Chem. & Met.* Vol. 45, p. 286, May, 1938.

Catalysis Costs Determine Economy In Contact Processes

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IN THE OPERATION of large-scale processes based on contact catalysis, detailed information on the cost of the catalysis step itself is desirable for several reasons. It makes possible a more accurate comparison between competing catalytic and non-catalytic processes. It is important in making selections between different catalysts for a given process. And in the operation of the process it determines when the catalyst should be discarded. The purpose of this article is to define catalyst costs and discuss their use in achieving more economic operation of catalytic processes.

Costs which are of interest in this study are not only those of making and installing catalysts and maintaining catalysis equipment, but they also include raw materials, power and general operating costs affected by the functioning of the catalyst.

The costs of operating the catalysis section of a process may be grouped under three headings: (1) initial cost, (2) cumulative operating losses, and (3) investment cost.

The first of these three classes includes the costs of installing catalysts. These have their origin in the cost of catalytic material, its preparation, recovery and installation in catalyst vessels. After a catalyst has been installed, its initial cost does not change during its operating life. Its initial cost per unit of product, however, will decrease rapidly with use and ultimately may become very small.

The second group of catalyst costs includes those resulting from cumulative losses. The nature of most catalysts and the effect of impurities carried by raw materials is such that the activity of the catalyst is impaired by use and the output of the process falls off. Loss of productivity arises from two types of changes. Some catalysts decrease in their ability to convert raw materials at the maximum chemical yield. Others are able to convert continually at maximum yield but decline in their ability to convert at maximum burden capacity. These changes in the activity of catalysts result in a loss of raw material and power when the chemical yield diminishes, or of operating and fixed costs if the burden capacity is reduced.

The method for determining cost of cumulative losses varies according to whether the losses originate from decreasing yields or decreasing burden capacity, but in either case the first step is to determine the amount of decrease in terms of percentage of the maximum. If the decrease is due to yield, the total cost of raw materials and power involved in the period of production under consideration is multiplied by the percentage decrease in yield. This gives the loss due to lower chemical yield. This loss is determined for each production period at the average yield decrease for that period, and the values are added to give the cumulative loss from yield decrease for the total production by the catalyst. Losses arising from diminishing burden capacity are determined by multiplying the operating and fixed charges for each production period by the percentage decrease in burden capacity. Dividing total loss by total production will give the cumulative loss per unit of product.

The third group of catalysis costs originates from the fact that many catalysts contain precious metals. These are not charged into the initial cost but are carried as an investment at current interest rates, and are classified as investment costs. For a given period of production the investment cost per unit of product is calculated by dividing the current interest rate on the investment in precious metals by the amount of production.

Classification of Catalysis Costs

I. Initial Costs
  A. Making and installing new catalyst
    1. Cost of materials
    2. Cost of making catalyst support and impregnating with catalytically active material.
    3. Opening catalyst vessels, removing old catalyst and making repairs arising from catalyst changes
    4. Installing new catalyst and restoring equipment to operating condition
  B. Cost of recovery of values from used catalyst
  C. Losses of valuable catalyst material
    1. During life of catalyst
    2. Recovery losses

These losses are the difference between the amount of recoverable materials in the original and in the spent catalyst.

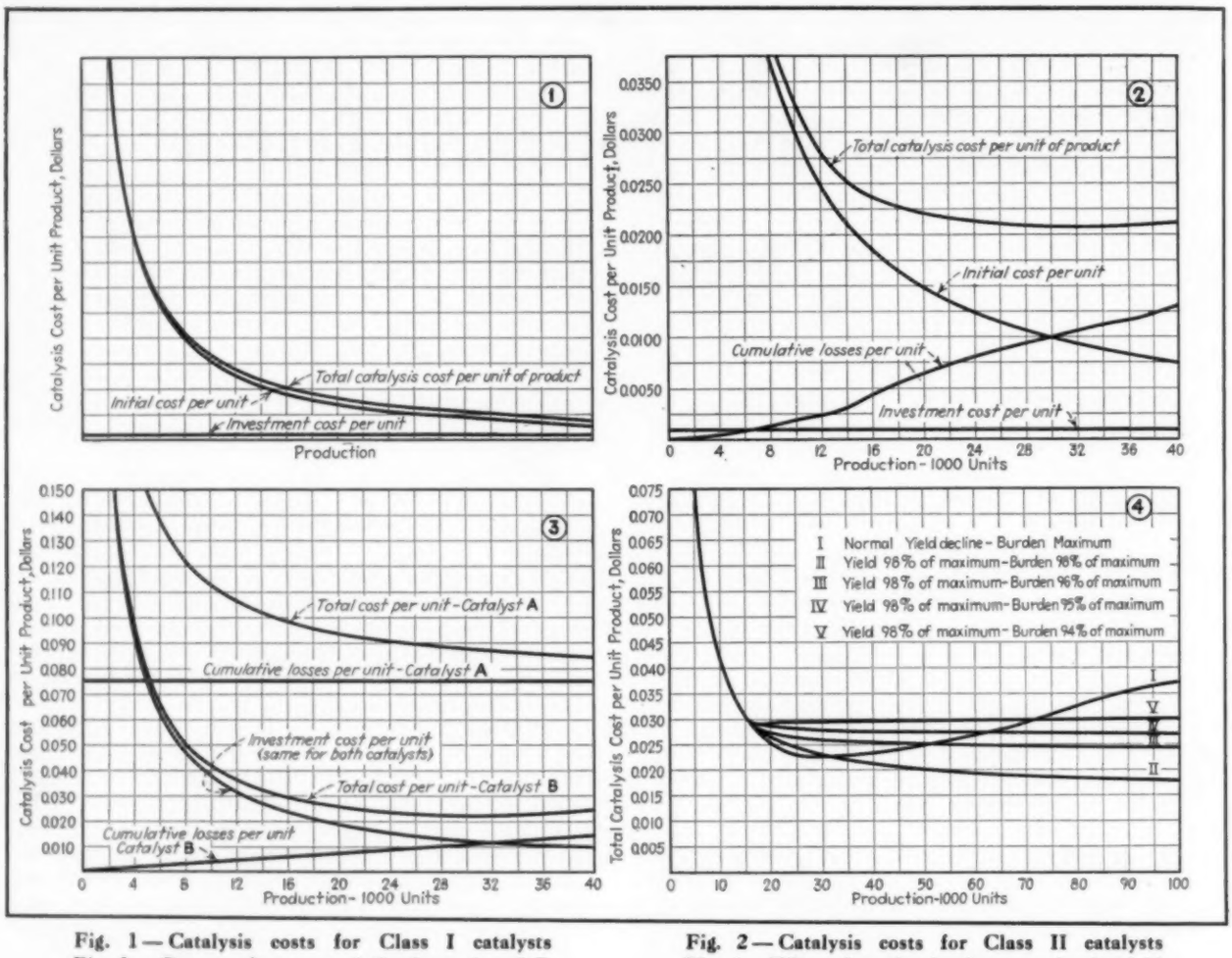
①
Catalysis Cost per Unit Product, Dollars
Total catalysis cost per unit of product
Initial cost per unit
Investment cost per unit
Production
②
Catalysis Cost per Unit Product, Dollars
0.0350
0.0300
0.0250
0.0200
0.0150
0.0100
0.0050
Total catalysis cost per unit of product
Initial cost per unit
Cumulative losses per unit
Investment cost per unit
0 4 8 12 16 20 24 28 32 36 40
Production - 1000 Units
③
Catalysis Cost per Unit Product, Dollars
0.150 0.140 0.130 0.120 0.110 0.100 0.090 0.080 0.070 0.060 0.050 0.040 0.030 0.020 0.010
Total cost per unit - Catalyst A
Cumulative losses per unit - Catalyst A
Investment cost per unit (same for both catalysts)
Total cost per unit - Catalyst B
Cumulative losses per unit Catalyst B
0 4 8 12 16 20 24 28 32 36 40
Production - 1000 Units
④
Total Catalysis Cost per Unit Product, Dollars
0.075 0.070 0.065 0.060 0.055 0.050 0.045 0.040 0.035 0.030 0.025 0.020 0.015 0.010 0.005
I Normal Yield decline - Burden Maximum
II Yield 98% of maximum - Burden 98% of maximum
III Yield 98% of maximum - Burden 96% of maximum
IV Yield 98% of maximum - Burden 95% of maximum
V Yield 98% of maximum - Burden 94% of maximum
0 10 20 30 40 50 60 70 80 90 100
Production - 1000 Units

Fig. 1 — Catalysis costs for Class I catalysts
Fig. 3 — Comparative costs of Catalysts A and B

Fig. 2 — Catalysis costs for Class II catalysts
Fig. 4 — Effect of cutting burden to maintain yield

D. Shutting down and starting up plant
   1. Extra Labor
   2. Fuel and power for bringing condition of new catalyst to operating range or for cooling down old catalyst
   3. Raw material during starting which is not catalyzed and thus lost

E. Idle plant charges:—During the shut-down period, labor, repair materials, laboratory and supervision costs continue to accumulate with no production against which they may be charged. In addition, fixed charges such as overhead, insurance, depreciation, taxes, etc., are being applied against the process. These must be calculated for the production lost by interruption of operation and added to the initial catalyst costs.

F. Excess cost of purchased product:—These costs should be determined when the plant is shut down for catalyst change, if product must be purchased to fill requirements. They will amount to the difference between the cost of the product from outside sources and the plant cost of raw materials and power for the same amount of product

The total initial cost is a constant for any installed catalyst. When it is divided by the total units of product made from the particular catalyst in question, the value obtained represents the initial catalyst cost per unit.

II. Cumulative Losses

A. Losses from decline in chemical efficiency
   1. Raw materials cost
   2. Power costs

These costs are determined by calculating the decrease from maximum yield in terms of a percentage of maximum yield, and applying this percentage decrease to raw materials cost and power costs. This procedure is carried out for each increment of production and the summation of the incremental costs represents the total cost of cumulative losses from decline in chemical efficiency.

B. Losses from reduced productive capacity
   1. Direct operating costs—labor, repairs, materials, supervision, and laboratory. Power is included in this group if the volume of material passing through the plant remains the same as at the higher production capacity, i.e., if the concentration of the reactant is decreased. If the total amount of material put through the plant is decreased in proportion to the decreased output, power is not included in this group.
   2. Fixed operating costs—depreciation, insurance, taxes, overhead

These costs are determined by calculating for each increment of production the percentage decrease

from maximum productive capacity and applying it to the combined direct and fixed operating costs for that increment. The total of these incremental costs represents the cost of cumulative losses from reduced productive capacity.

To obtain the total cumulative losses per unit of product, costs A and B are added together and divided by the total units of product obtained from the catalyst.

III. Investment Cost:—The cost of investment in valuable catalyst material is part of catalysis costs. It is a constant amount per unit of product and consists of the interest charge at prevailing rates on money invested in valuable and readily salable catalyst material, such as platinum. Materials used in catalysts which have no value after use are not in this category. Their cost is included in the initial cost and no investment cost applies to their operation.

The above three classifications include all costs that enter into the catalysis step. For some catalysts only two of these groups comprise the total cost, while for others all three must be considered. Consequently it has been found convenient to divide catalysts into two types, based on the cost groups included in their total cost.

The first or Class I type of catalyst consists of those which do not decrease in productive capacity. Therefore no cumulative losses are incurred in their use—only initial and investment costs. When the latter are known, all information is available for calculating total catalysis costs. For Class I catalysts, then, the total cost per unit of product is equal to initial cost per unit plus catalyst investment charges per unit. This cost will continually diminish as production increases, since the initial cost per unit is continually decreasing while the investment cost remains constant. When a large amount of product has been made with a catalyst of this type, the total catalysis cost will have diminished to such an extent that it will be practically equal to the investment cost (see Fig. 1).

Class II catalysts include those which fall off continuously in productive capacity as a result of use. Cumulative losses result and consequently this cost must be included along with initial and investment costs in determining the total catalysis cost.

Fig. 2 shows curves for the three groups of costs which enter into the total for Class II catalysts. The curve for total cost per unit of product is also shown and represents the sum of the other three curves. It will be noted that the total cost curve decreases rapidly at the start of the catalyst life because rapidly declining initial cost is the factor of greatest influence. The cumulative losses then begin to affect the total cost, while the initial cost declines less precipitously. Less rapid changes in total cost, therefore, occur in this portion of the curve. Finally the total cost changes by hardly perceptible amounts, passes through a minimum value and slowly increases under the influence of rapidly mounting cumulative losses.

Determination of Catalyst Life

Catalysis costs find their application in controlling the operation of catalytic processes. They are used for determining the economic life of the catalyst, for selecting the proper catalyst to be used, and in making decisions on process conditions to be rendered on the basis of minimum total catalysis costs.

Economic life of a catalyst indicates the production which should be obtained before the catalyst is renewed, and it may be defined as the number of units of product obtainable from the catalyst at the lowest catalysis cost per unit. Methods for determining the economic lives of the two classes of catalysts are as follows:

Class I—Since the total catalysis cost per unit of product for this type of catalyst continually decreases to approach a constant equal to the investment cost, it is evident that the minimum will never be reached and that the theoretical life of Class I catalysts is infinitely great.

Class II—Catalysts in this group have a finite economic life. From what has been said about their total costs, it will be noted that these decrease to a minimum and then increase. The production at the point where

Table I—Catalysis Costs for Class II Catalyst

			Cumulative Losses								
Production Increment	Cumulative Production (P)	Initial Cost Per Unit of Product, Cents	Average Yield Per Cent	Yield Decrease as Per Cent of Max. (d)	Raw Mat. Plus Power Costs (l) Dollars	l x d Dollars	Σld Dollars	Cum. Loss Per Unit Σld/P Cents	Investment Cost per Unit Cents	Total Cost Per Unit Cents
1,322	1,322	22.579	97.19 (Max.)	0.00	$787	0.00	0.00	0.000	0.086	22.665
2,388	3,710	8.044	97.08	0.11	1,424	1.57	1.57	0.042	0.086	8.172
2,429	6,139	4.862	96.96	0.24	1,448	3.48	5.05	0.083	0.086	5.031
2,179	8,318	3.588	96.62	0.59	1,305	7.70	12.75	0.153	0.086	3.827
2,372	10,690	2.792	96.57	0.64	1,415	9.06	21.81	0.204	0.086	3.082
2,067	12,757	2.340	96.40	0.81	1,232	9.98	31.79	0.249	0.086	2.675
2,283	15,040	1.984	95.50	1.74	1,360	23.65	55.40	0.369	0.086	2.439
2,260	17,300	1.725	94.91	2.35	1,346	31.63	87.07	0.503	0.086	2.314
2,304	19,604	1.523	94.73	2.53	1,375	34.80	121.87	0.622	0.086	2.231
1,921	21,525	1.387	94.67	2.60	1,144	29.75	151.62	0.704	0.086	2.177
2,138	23,663	1.262	94.59	2.68	1,273	34.10	185.72	0.785	0.086	2.133
2,174	25,837	1.155	94.34	2.93	1,295	37.96	223.68	0.865	0.086	2.106
2,154	27,991	1.066	94.29	2.98	1,284	38.27	261.95	0.936	0.086	2.088
2,160	30,151	0.989	94.14	3.14	1,287	40.40	302.35	1.002	0.086	2.077
2,146	32,297	0.924	94.00	3.28	1,278	41.90	344.11	1.065	0.086	2.075
2,160	34,457	0.866	93.85	3.44	1,287	44.25	388.50	1.128	0.086	2.080
2,140	36,597	0.815	93.70	3.59	1,276	45.80	434.30	1.187	0.086	2.088
2,145	38,742	0.770	93.30	4.00	1,278	51.10	485.40	1.253	0.086	2.109
2,150	40,892	0.730	93.00	4.31	1,281	55.29	540.60	1.322	0.086	2.138

the minimum total cost is reached is the economic life of Class II catalysts.

The catalysis costs of a number of catalysts of this type with constantly diminishing activity have been determined and it has been found that their minimum total cost is obtained when the initial cost and cumulative loss per unit of product are approximately equal. It also follows then that their economic life ends at this point. This does not mean, however, that the catalyst is no longer able to function, but only that further production will be uneconomical.

Example—Table I gives the values of the various cost factors for a Class II catalyst. This catalyst suffered a decline in chemical efficiency but not in productive capacity. The original data from which Table I was constructed are as follows:

Initial catalyst cost.....	$298.50
Investment cost per unit of product....	0.00086
Raw materials plus power costs per unit of product	0.5956

The costs of this catalyst as indicated in Table I are shown in graphical form in Fig. 2. The minimum total cost is obtained at a production of approximately 32,000 units of product. This constituted the economic life of this particular catalyst. From the minimum there is a very slight but definite rise in total cost. The set of cost curves in Fig. 2 is characteristic of those obtained for Class II catalysts.

Strictly considered, all determinations of catalyst life are on the basis of amount of product made by the catalyst. In many operations, monthly production from a given catalyst is fairly constant and therefore no great error will be introduced if catalyst life is based on elapsed time in monthly periods. In a process using two catalysts in series, each must be studied separately, with respect to its economic effect on the operation of the whole process.

After the efficiency characteristics of a catalyst are known, its life can be determined and renewal dates anticipated. When a catalyst of an untried type is being used, it is not possible to predict its life exactly. The most practical procedure in such a case is to plot the curves for cumulative losses and investment cost at the end of each production period. These will begin to approach equality some time before they intersect.

In most cases the curve of total costs is very flat before and after its minimum, so that no great monetary loss will occur if there is a short delay in renewing the catalyst after it has passed its economic life.

Comparison of Catalysts

The methods which have been outlined may also be used to determine comparative costs for different catalysts intended for the same purpose. In some cases these may have similar efficiency characteristics in varying degrees while in others they may possess different types of productive efficiencies. In the first instance, where the catalysts possess different rates of decrease in chemical yield at the same production rates, selection will be comparatively easy. Where the catalysts under consideration have different operating characteristics, i.e., one developing a declining yield efficiency at a maximum output rate while another may work with a maximum chemical yield at a declining or constant lower output, selection is not quite as easy. An example of the application of cost principles in making a selection of this type is given in the problem which follows.

The catalysts which will be considered are assumed to differ in that one has a maximum constant chemical efficiency at a lower output capacity, while the other has a declining chemical efficiency at higher constant production capacity. The first will be a Class I and the second a Class II catalyst.

This difference in output capacity is assumed to arise from a frequently encountered characteristic of catalysts: the fact that some cannot convert with economic chemical efficiency when the concentration of the reactant in its transporting diluent exceeds certain percentages. Under these conditions, the catalyst which is able to work only at lower concentration of reactant will produce less in the same interval of time than the other catalyst. The total volume of reactant plus diluent passing through the plant in a given period will be the same for either catalyst, and total operating costs for the period will be equal. The catalyst having the lower output will, therefore, have a higher operating cost per unit. This will show up in the cost of cumulative losses.

The second catalyst will operate at a constant higher output because of the higher concentration of reactant it can handle. This output can be considered as the maximum for purposes of comparison. Cumulative losses for this catalyst will be those arising from declining chemical efficiency.

In this illustration both catalysts are assumed to have the same installation cost, and investment costs are assumed to be absent. Basic data for the two catalysts are as follows:

Catalyst A
- Installation cost, $375.00
- Chemical yield efficiency, constant at 97.0 per cent
- Concentration of reactant, 8.0 per cent
- Output constant at 800 units per month

Catalyst B
- Installation cost, $375.00
- Chemical yield efficiency: 97 per cent initially, declining 0.125 per cent of maximum successively per 1,000 units of product
- Concentration of reactant, 10.0 per cent
- Output constant at 1,000 units per month

Process data—applies to both catalysts
- Raw material cost, $0.50 per unit of product
- Power cost, $40.00 per month
- Operating costs other than power, $260.00 per month
- Total operating cost (sum of power and other costs), $300.00 per month

Costs calculated from the above data are presented in Table II. The first column shows the production increments used in the calculations. In the second column are initial costs per unit of product. These apply to both catalysts since the total initial costs for the two were assumed to be equal. The costs in the remaining four columns were calculated as follows:

Catalyst A—The operating cost for this catalyst is $\frac{\$300}{800}$ or $0.375 per unit of product. For the maximum plant capacity using Catalyst *B*, it is $\frac{\$300}{1,000}$ or $0.300 per unit. The difference between these two figures, or $0.075 per unit of product, is the cumulative loss for Catalyst *A*. This is a constant value for all production

by this catalyst, and is given in the third column of Table II.

In the fourth column, the total cost per unit of product for Catalyst *A* is given as the sum of the initial cost and cumulative loss as determined above.

Catalyst B—The production from this catalyst is uniform at 1,000 units per month. Therefore raw material cost plus power cost will be constant at $540 per monthly increment of 1,000 units. For the first thousand units, the decline in chemical efficiency expressed in terms of percentage of maximum efficiency is 0.125 per cent. Applying this to the $540, we obtain a cumulative loss of $0.675 for the increment. When this is divided by 1,000, a cumulative loss per unit of product is obtained amounting to $0.000675, or, to express the figure to the closest thousandth as has been done in the fifth column of Table II, $0.001.

For each succeeding increment the product of $540 times percentage decline in efficiency for that increment is obtained, is added to the summation of similar products for preceding increments, and the total divided by the total production to that point. The values thus obtained represent cumulative loss per unit of product for Catalyst *B* and are recorded in the fifth column of Table II.

The sixth column values, which represent total catalysis cost, are the sums of corresponding initial costs and cumulative costs shown in the second and fifth columns.

The various costs for catalysts *A* and *B* are shown graphically in Fig. 3. It will be noted that the total catalysis cost for Catalyst *A* constantly diminishes since it is a Class I catalyst. It approaches its cumulative loss, which is constant, as a minimum, but never falls below it. The lowest catalysis cost attainable with this catalyst is therefore $0.075 per unit of product.

The minimum catalysis cost of Catalyst *B* is determined by its economic life at approximately 32,000 units of product. This cost is $0.022 per unit of product.

Catalyst *B* is therefore the cheapest catalyst of the two for use in the plant in question, even though its economic life is limited and the expense of renewal must be borne after every 32,000 units of production. The high comparative catalysis cost for Catalyst *A* is due to its low output capacity.

Determination of Operating Policy

Catalysts with declining activity can often have the nature of this decline modified by controlling process conditions. In many instances decline in chemical yield can be arrested or eliminated by decreasing the burden, i.e., the amount of raw material passing through the process. Sometimes advantage is taken of this fact to maintain or restore chemical yield efficiency at the expense of output capacity. The extent to which the burden may be cut for maintaining yield to improve catalysis cost is ascertained by comparing costs of various operating methods. In Fig. 4 this has been done for Catalyst *B* described above. Curve I shows the appearance of total catalysis cost when the yield is declining without interruption and the burden is constant at the maximum of 1,000 units per month. Curves II, III, IV and V show what happened when the burden was cut to 98 per cent, 96 per cent, 95 per cent and 94 per cent of maximum respectively after the yield had declined 2 per cent.

The cumulative losses in the first curve will contain only those due to lessened chemical efficiency. In the other curves they will still contain losses due to chemical inactivation but in smaller amounts than in the first method. They will also include cumulative losses from decreased output. These results indicate that lower costs can be obtained if a cut in burden to 98 per cent of maximum is made for the purpose of maintaining the yield at 2 per cent below its maximum efficiency.

A 4 to 5 per cent cut in burden would result in a minimum total cost lower than that obtained with normal yield decline at full burden only if it were possible to operate the catalyst for an infinitely great production.

Costs have also been determined for the same catalyst and process assuming that the yield can be restored to maximum by cutting burden. In this case it is assumed that the yield had fallen 2 per cent of the maximum and is brought back to full yield by a burden cut.

The cumulative losses from chemical yield disappear after the yield is restored and from this point have their origin only in decreased production rates. The burden could be reduced to 90 per cent of maximum in this case and costs would be obtained that are lower than those which would result if the yield were allowed to continue its decline uninterrupted.

The author wishes to express his appreciation of suggestions made by Dr. William C. Kay of the Industrial Engineering Division, E. I. duPont de Nemours & Co., Inc., in connection with this article.

Table II—Catalysis Costs for Catalysts A and B

		Catalyst A		Catalyst B	
Production Increment	Initial Cost	Cum. Loss	Total Cost	Cum. Loss	Total Cost
0000– 1000	$0.375	$0.075	$0.450	$0.001	$0.376
1000– 2000	0.188	0.075	0.263	0.001	0.189
2000– 3000	0.125	0.075	0.200	0.001	0.126
3000– 4000	0.094	0.075	0.169	0.002	0.096
4000– 5000	0.075	0.075	0.150	0.002	0.077
5000– 6000	0.063	0.075	0.138	0.002	0.065
6000– 7000	0.054	0.075	0.129	0.003	0.057
7000– 8000	0.047	0.075	0.122	0.003	0.050
8000– 9000	0.042	0.075	0.117	0.003	0.045
9000–10000	0.038	0.075	0.113	0.004	0.042
10000–11000	0.034	0.075	0.109	0.004	0.038
11000–12000	0.031	0.075	0.106	0.004	0.035
12000–13000	0.029	0.075	0.104	0.005	0.034
13000–14000	0.027	0.075	0.102	0.005	0.032
14000–15000	0.025	0.075	0.100	0.005	0.030
15000–16000	0.023	0.075	0.098	0.006	0.029
16000–17000	0.022	0.075	0.097	0.006	0.028
17000–18000	0.021	0.075	0.096	0.006	0.027
18000–19000	0.020	0.075	0.095	0.007	0.027
19000–20000	0.019	0.075	0.094	0.007	0.026
20000–21000	0.018	0.075	0.093	0.007	0.025
21000–22000	0.017	0.075	0.092	0.008	0.025
22000–23000	0.016	0.075	0.091	0.008	0.024
23000–24000	0.016	0.075	0.091	0.008	0.024
24000–25000	0.015	0.075	0.090	0.009	0.024
25000–26000	0.014	0.075	0.089	0.009	0.023
26000–27000	0.014	0.075	0.089	0.009	0.023
27000–28000	0.013	0.075	0.088	0.010	0.023
28000–29000	0.013	0.075	0.088	0.010	0.023
29000–30000	0.013	0.075	0.088	0.010	0.023
30000–31000	0.012	0.075	0.087	0.011	0.023
31000–32000	0.012	0.075	0.087	0.011	0.023
32000–33000	0.011	0.075	0.086	0.011	0.022
33000–34000	0.011	0.075	0.086	0.012	0.023
34000–35000	0.011	0.075	0.086	0.012	0.023
35000–36000	0.010	0.075	0.085	0.013	0.023
36000–37000	0.010	0.075	0.085	0.013	0.023
37000–38000	0.010	0.075	0.085	0.013	0.023
38000–39000	0.010	0.075	0.085	0.014	0.024
39000–40000	0.010	0.075	0.084	0.014	0.024

Full-Scale Production Of Metaphosphate Achieved At Wilson Dam

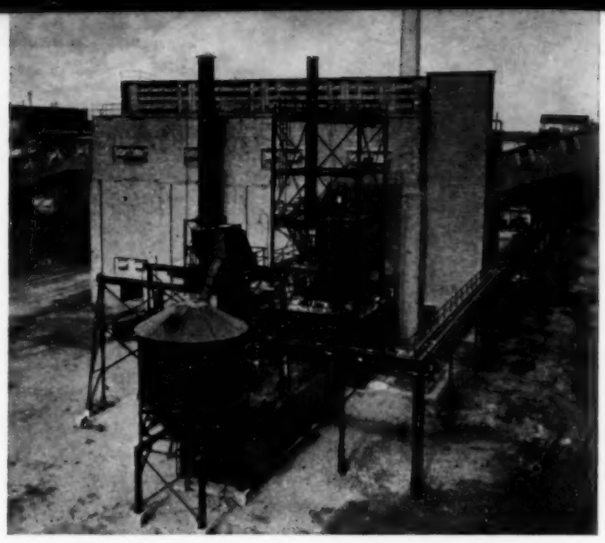

Fig. 1—T.V.A.'s new metaphosphate unit at Wilson Dam

By H. A. CURTIS, R. L. COPSON, A. J. ABRAMS,* and J. N. JUNKINS

TENNESSEE VALLEY AUTHORITY, WILSON DAM, ALABAMA

Subsequent to the account in *Chem. & Met.* last year of T.V.A.'s semi-works scale investigation of calcium metaphosphate as a cheap fertilizer[1], a new full-scale unit capable of producing 2 tons of metaphosphate per hour has been built at Wilson Dam, Ala. The following article describes the design changes in the new unit and the operating results to date. Also presented is a description of a proposed complete multi-unit plant—including estimates of capital expenditure and cost of production—which has been laid out on the basis of results obtained from the present unit.

IN THE NEW FULL-SCALE UNIT for production of crude calcium metaphosphate from phosphorus and rock phosphate at Wilson Dam (Figs. 1, 2, 3,), the principal change from the semi-works unit was made necessary primarily by the difficulty in handling the hot, corrosive exhaust gases. In the semi-works a steam ejector was used successfully to draw the gases from the combustion chamber through the tower. This arrangement was not considered practical for the large unit, and the scheme adopted was to supply the air for combustion under pressure, maintaining enough pressure in the combustion chamber to drive the products of combustion up through the absorption column.

Phosphorus for use in the metaphosphate plant is stored under water in underground concrete tanks. Each tank has a capacity of 20,000 lb. of phosphorus and is lined with acid-proof brick and provided with steam coils. From the tanks the phosphorus is circulated by submerged vertical centrifugal pumps through a pipe loop from which a metering pump takes the requisite quantity and delivers it to the burner. All pipe lines through which phosphorus is pumped are kept hot by winding with copper tubing through which steam is passed and over which insulation is applied.

The burner disperses the phosphorus by a jet of high pressure air into the horizontal section of the combustion chamber, as shown in Fig. 2. As the unit was constructed originally, the horizontal section of the combustion chamber was not included, the phosphorus being introduced directly into the vertical section. This arrangement might have been satisfactory with relatively clean phosphorus, such as was used in the semi-works furnace, but in practice it was necessary to handle crude phosphorus carrying considerable proportions of solid impurities and water. Initial attempts to operate the unit with sludge of this character showed that the phosphorus was not completely burned in the vertical chamber. The horizontal section was then added to provide more combustion space.

Centrifugal compressors are used to supply the air, as shown in Fig. 2. Each compressor will furnish about 2,500 cu.ft. of air per minute at a pressure of about 2 lb. per square inch. Enough air is blown into the horizontal section to burn part of the phosphorus, thus maintaining a high enough temperature to vaporize the balance of the phosphorus and the water in the sludge. Additional air is blown tangentially into the vertical chamber in such a way that the air strikes the gas stream from the vaporizer section at right angles. This arrangement insures complete combustion of the phosphorus before the hot gases enter the absorption tower.

Lump rock phosphate is weighed and then delivered to the top of the absorption tower by means of a skip hoist. Charging is done at intervals as required. For best operation the rock should be screened to remove pieces less than ⅜ in. in size. The maximum size of the lump rock ordinarily is about 3 in. but lumps up to 8 in. have been used.

The calcium metaphosphate formed in the tower by the absorption of the P_2O_5 is a viscous material which flows downward through the tower and drains into the pool in the bottom of the vertical section of the combustion chamber. It is withdrawn periodically as a molten glass-like substance.

Further work remains to be done on improvement of the means for supporting the rock in the absorption tower. At the constriction where the rock is supported, conditions are especially severe because of the high gas velocities, high temperatures, and corrosive action of the gas and of the molten calcium metaphosphate. The

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materials used so far in constructing the rock supports have not lasted for a sufficient time to be satisfactory. In the latest design, the horizontal and inclined rock supports shown in Fig. 2 are constructed of a cast refractory material, 20 per cent "Lumnite" cement and 80 per cent calcined flint clay grog, and are cooled by water pipes imbedded in the refractory. The rock supports are faced with zircon refractory blocks, since this is the most resistant material that has been found to date. It is believed that this problem will be solved satisfactorily.

The lower part of the combustion chamber, where the pool of molten calcium metaphosphate forms, is lined with "Corhart" refractory. The other refractories used are high-grade firebrick or stiff mud brick. Except for the rock supports, the refractories used have given satisfactory service. Both sections of the combustion chamber are arranged for water-cooling of the steel shell in order to protect the refractories.

Operating Results

In starting up the unit, oil is burned in the combustion chamber to raise the temperature approximately to the operating level, when a shift is made to phosphorus. In operation, the temperatures are maintained at the desired operating levels by varying the phosphorus and air rates. The phosphorus may be varied from 600 to 900 lb. per hour by changing the speed of the metering pump. By control of the air rates, the temperature in the horizontal section of the combustion chamber is maintained at 1800 deg. to 2200 deg. F., and a temperature of 1900 deg. to 1920 deg. F., is maintained at the point where the gases enter the absorption tower.

Under the conditions indicated, it has been found that a 6-ft. depth of rock is adequate for practically complete absorption of the P_2O_5 in the absorption tower. The rate of absorption is very rapid, and from observation it appears that most of the P_2O_5 is absorbed in the lowest one to two feet of the rock bed. Large losses of P_2O_5 occur only when channels form through the rock bed. However, the operators are able to break up these channels and maintain uniform gas distribution by "rodding" the charge through poke holes in the side of the tower. The results so far indicate that an average recovery of 98 per cent of the P_2O_5 can be achieved.

The capacity of the unit varies somewhat with the purity of the phosphorus available, and with the grade of the rock phosphate charged to the tower. A low quality phosphorus necessitates a decrease in the rate of burning. Under favorable conditions, the unit described will produce 2 tons per hour of calcium metaphosphate. It is of interest to note that there is the possibility of recovering about 75 lb. per hour of fluorine from the waste gas from this unit.

The molten metaphosphate is tapped from the combustion chamber at a temperature of about 2200 deg. F. At this temperature it is relatively fluid. From results obtained in the semi-works, it was planned to quench this molten, glass-like product as follows: A water-cooled rotating paddle wheel was installed to break up the stream of molten metaphosphate into small pellets, and to project them into a rotating steel drum about 5 ft. in diameter by 50 ft. long; water sprays were provided inside the drum for cooling. However, in the full-scale plant it was not found possible to quench the product satisfactorily with this equipment without using an excessive amount of water, thus producing a wet material. After further experiments the following method was adopted: The molten metaphosphate is allowed to flow into the inside of the same drum, which is water-cooled on the outside; the drum is rotated slowly, thus causing a layer of metaphosphate to adhere to the inside wall; when the layer cools, it cracks and falls away from the wall. In this way a dry, flaked product is obtained.

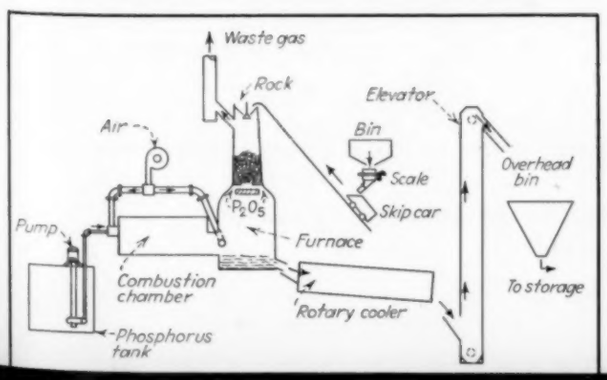
The product from the cooling drum is elevated into a storage hopper and is then taken to the storage building.

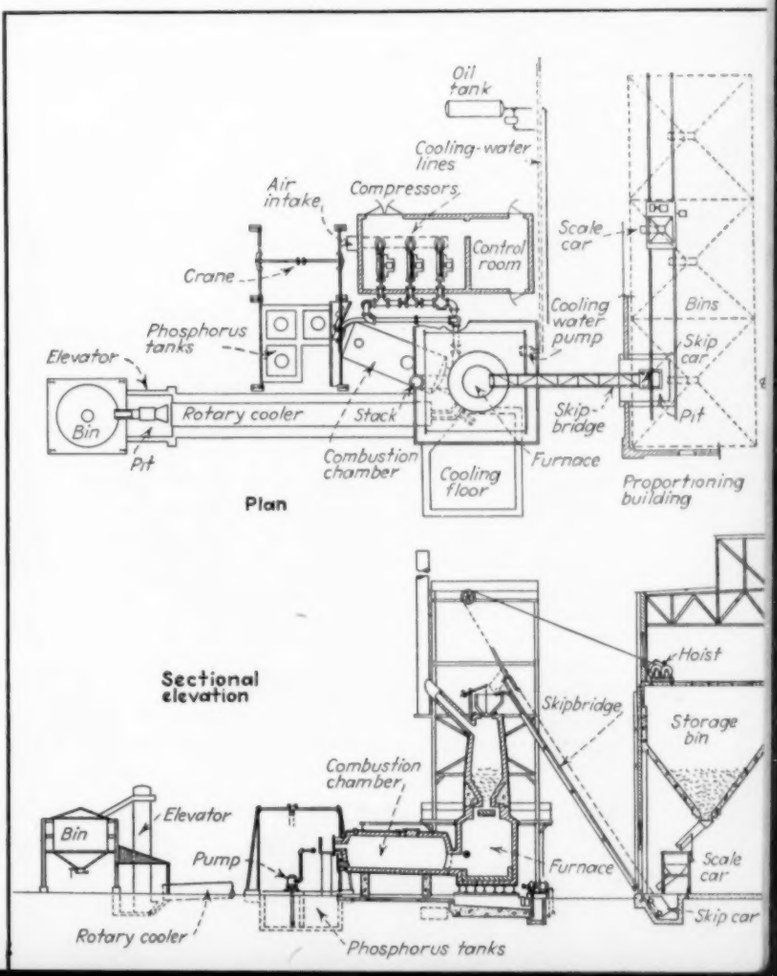
Grinding, Screening, and Bagging

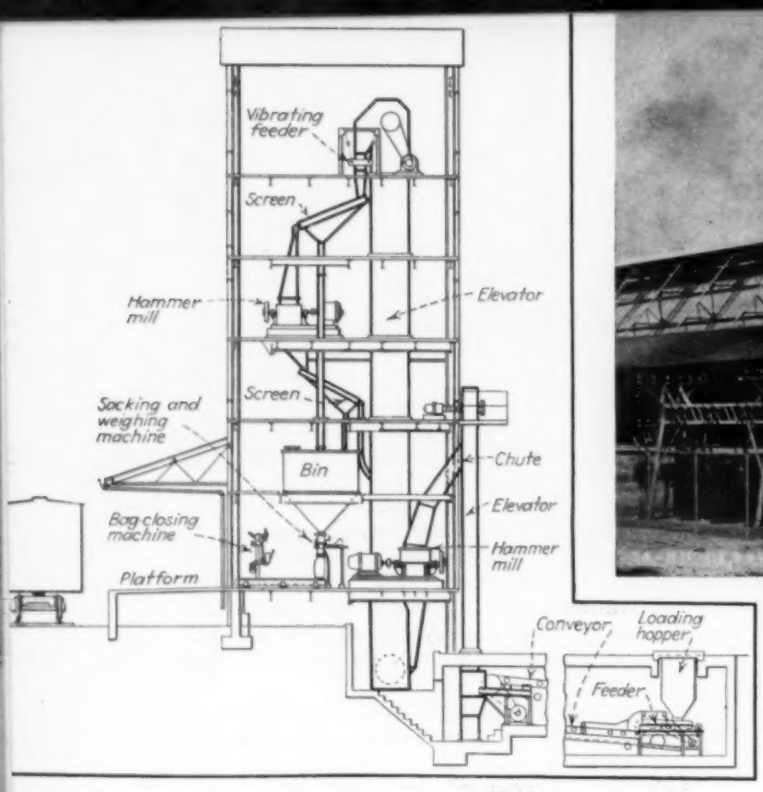
The metaphosphate is stored in the double A-frame building shown in Fig. 5. It is recovered from the stock pile by an electrically operated power shovel and carried to a floor hopper by means of small, gasoline-driven dump trucks. A conveyor belt, running in a tunnel below floor level, delivers the metaphosphate to the grinding, screening, and bagging plant. A diagram of this plant is given in Fig. 4 and a photograph of the plant in Fig. 5.

The metaphosphate is crushed and screened, and the oversize re-crushed. Experience in the field with metaphosphate fertilizer is as yet too limited to fix the opti-

Fig. 2, right—Elevation and plan of full-scale unit at Wilson Dam for making calcium metaphosphate from phosphorus and rock phosphate. Fig. 3, below—Flow diagram showing sequence of operations in unit at right







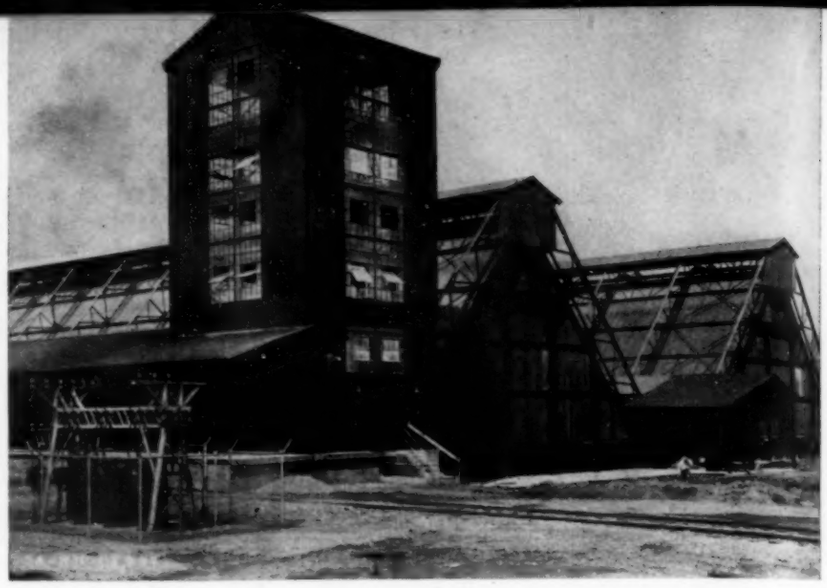


Fig. 4, left—Diagram of metaphosphate bagging and shipping plant. The material is carried to this building from the adjacent storage building by means of the underground conveyor shown at lower right. Fig. 5, above—Bagging and shipping building in foreground. Double A-frame storage building in background

mum particle size, but there are indications that fine grinding will not be necessary.

Description of Proposed Plant

A layout of the proposed complete plant is shown in Fig. 6. All buildings, except office, laboratory, and boiler house, are steel structures covered with protected metal roofing and siding, and floored with concrete. The office and laboratory building is of fireproof brick-steel-tile construction, and the boiler house has a steel frame and tile walls.

At the proportioning building, the sintered or nodulized phosphate for the electric furnaces, the lump rock phosphate for the metaphosphate units, and the dried coke required, are all received from the raw materials preparation plant on two belt conveyors, thus eliminating railroad trestles, track hoppers and storage facilities for raw materials. From the proportioning building bins the materials are withdrawn by means of a weigh-car.

The electric furnaces are 3-phase, rectangular in shape, and use 30-in. carbon electrodes. The molten slag is granulated by water jets and is pumped to a slag disposal pit. The phosphorus condensing units consist of brick-lined steel towers in which the furnace gas is sprayed with water, followed by smaller coke-packed towers which serve as entrainment separators.

The mixture of liquid phosphorus and water from the condensing system is pumped to a lead and brick lined thickener with bronze rake where the phosphorus and sludge-forming solids are separated from the water. The overflow water from the thickener is pumped to the condenser sprays. The phosphorus is stored in underground concrete tanks lined with acid-proof brick. Each of these tanks is provided with a central launder for withdrawing the excess water carried over with the phosphorus and is fitted with a stainless steel cover, steam coil, and float.

Each of the metaphosphate units is similar to the one shown in Fig. 2. The horizontal section of the phosphorus burner is a cylindrical, brick-lined chamber, 8 ft. in diameter and 30 ft. long, connected to a vertical combustion chamber 15 ft. in diameter and 18 ft. high, above which is the absorption tower. Lump phosphate is delivered to the top of the tower by a skip hoist. Air for the combustion chambers is supplied by three centrifugal compressors.

The storage building consists of two A-frame parallel units, each 90 ft. wide and 400 ft. long with a 20-ft. covered aisle between them. The metaphosphate is delivered into storage by an automatic monorail dump carrier, and is removed by an electric power shovel.

The final preparation building and the grinding, screening, and bagging equipment are similar to that shown in Fig. 4.

A detailed account of estimated costs and capacity of the new plant is given on the following page.

Fertilizer Value of Metaphosphate

The neutral ammonium citrate test, which is universally used to determine the degree of "availability" of the P_2O_5 in superphosphate, showed that practically all of the P_2O_5 in metaphosphate is available. However, inasmuch as calcium metaphosphate had not been used as a fertilizer, it was necessary to subject the new material to tests with growing plants. Many agricultural experiment stations have tested the metaphosphate produced in the semi-works under greenhouse conditions and in plots out of doors, with various crops and various soils. Some of the results have been published and others will no doubt follow. There is no longer a question as to the fertilizer value of metaphosphate, but much more experience in use of the material must be gained before all of its fertilizer characteristics are known

Why Use Concentrated Phosphate?

Certain folks whose legitimate interest in selling low grade phosphate is about equal to their conviction that there can be no advantages in new technology have

recently published statements pointing out that the cost per unit of available P_2O_5 is greater in concentrated superphosphate than in ordinary superphosphate, meaning (but never saying) costs f.o.b. stock pile, or f.o.b. plant. Let us now inquire as to costs f.o.b. the farmer.

Consider three plants located equally distant from a farmer who pays a freight charge of $4.50 per net ton on fertilizer purchased. At one of the plants, bulk superphosphate averaging 16⅔ per cent available P_2O_5 is offered at $9 per ton in the stock pile; at another of the plants, bulk superphosphate averaging 50 per cent available P_2O_5 is offered at $33 per ton in the stock pile; at the third plant, metaphosphate carrying 65 per cent available P_2O_5 is offered at $40 per ton in the stock pile. Assume that the following costs apply to all three:

Recovery from storage, crushing, screening, and bagging	$1.00 per ton
Bags	1.75 " "
State tax	.50 " "
Freight	4.50 " "
Dealer's profit	10 per cent

The cost per ton of available P_2O_5 to the farmer is then:

	16⅔% Material	50% Material	65% Material
In stock pile	$54.00	$66.00	$61.50
Recovery, crushing, etc.	6.00	2.00	1.54
Bags	10.50	3.50	2.69
State tax	3.00	1.00	0.77
Freight	27.00	9.00	6.92
Dealer's profit	10.05	8.15	7.34
Cost to farmer	$110.55	$89.65	$80.76

The metaphosphate is not as yet available on the market, but concentrated superphosphate is. Why does not the farmer buy it and save money? There are several reasons, of which the following are usually prominent:

(a) The farmer has a call loan from the local bank, which in turn owns an interest in a local dry mixing plant. The farmer also owes money to a local dealer who handles the products from the local mixer.

(b) The farmer's idea of a good fertilizer is something that the local dealer sells in bags under a fancy trade brand. The farmer is almost sure to take the bag which costs least, is the biggest, or the most evil smelling.

(c) It is more profitable to sell the farmer what he will buy than to try to sell him what he should buy.

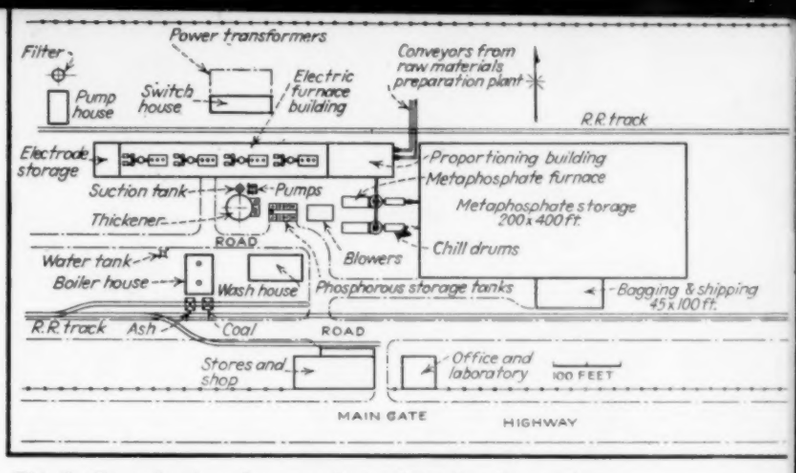


Fig. 6—Grounds plan of proposed complete plant for production of calcium metaphosphate

References

(1) Curtis, H. A., Copson, R. L., Abrams, A. J., Metaphosphate Investigation Aims at Cheaper Fertilizer. *Chem. & Met.*, **44**, March, 1937.

(2) Curtis, H. A., Miller, A. M., Junkins, J. N., TVA Estimates Favorable Costs for Concentrated Superphosphate. *Chem & Met.*, **43**, Nov. & Dec., 1936.

Cost Estimates for Proposed Complete Metaphosphate Plant

For the purpose of this paper, cost estimates for the proposed plant described above are based on a location in central Tennessee near a suitable phosphate deposit. The plant consists of four electric furnaces and condensers and two metaphosphate units. The step of condensing the phosphorus is included, since the present full-scale unit was developed to use elemental phosphorus. It is assumed that the four electric furnaces will draw an average of 5,500 kw. and that each metaphosphate unit will use the phosphorus from two furnaces.

Raw Materials and Plant Output

The plant will receive dried coke, nodulized phosphate for use in the electric furnaces, and lump phosphate for the metaphosphate units from an adjacent raw materials preparation plant.

In order to get a favorable rate on power, the four electric furnaces will be operated for a 300-day period, and two of the four electric furnaces will be operated during the remaining 65 days each year. It is assumed that the furnaces use 90 per cent of the power for the whole plant, and that the plant will operate 98 per cent of the elapsed time. During the 300-day period the total power consumed will be 172,500,000 kw. hours, or at the rate of 17,500,000 kw.-hr. per month. During the 65-day period the total power consumed will be 18,700,000 kw.-hr., or at the rate of 8,740,000 kw.-hr. per month. The total power consumed per year will be 191,200,000 kw.-hr.

A furnace drawing 5,500 kw., using nodulized phosphate carrying 24.5 per cent P_2O_5, will smelt 4.04 tons of nodules per hour. Four furnaces operating 98 per cent of the elapsed time during 300 days, and two furnaces operating 98 per cent of the elapsed time during the remaining 65 days of the year will smelt 126,350 tons of nodules per year.

Screened coke breeze will be used in the furnaces. The coke (83 per cent fixed carbon) required per ton of nodules of the grade assumed is approximately 282 lb. Allowing for a 15 per cent loss of weight during drying and handling, the requirement will be 332 lb. of coke as received per ton of nodules. The 126,350 tons of nodules smelted will therefore require approximately 21,000 tons of coke as purchased.

The distribution of the phosphorus charged to the furnaces in the nodulized material will be as follows:

	Per Cent Out	Per Cent In
Charged as nodules		100
Recovered as phosphorus	80.8	
Recovered in ferrophos	9.0	
Lost in ferrophos	0.8	
Lost in slag	5.4	
Lost in waste gases, etc.	4.0	
Total	100.0	100

The annual production of elemental phosphorus will be 10,930 tons per year. The recovered ferrophos, carrying 25.5 per cent phosphorus, will be 4,770 tons per year. The slag produced will be approximately 96,000 tons.

It will be assumed that the lump phosphate delivered from the raw materials preparation plant for use in the metaphosphate units will analyze 33.0 per cent P_2O_5 and 46.8 per cent CaO. If the absorption of P_2O_5 in the metaphosphate tower be taken at 98 per cent of that delivered to the tower, and if metaphosphate be produced having a P_2O_5/CaO mol ratio equal to 1.0, then the amount of dry lump rock required will be 28,600 tons per year.

The metaphosphate will contain 66.0 per cent P_2O_5, and the annual production of metaphosphate will be in the neighborhood of 51,400 tons.

The recoverable carbon monoxide by-product from the phosphorus condensers will amount to about 750,000,000 cu. ft. per year. Inasmuch as the raw materials preparation unit is to be adjacent to the metaphosphate plant, this gas may be utilized as fuel in the nodulizing kilns.

A small steam plant will be needed in a plant producing and handling elemental phosphorus. Two boilers, each of 300 b.h.p., will be installed, one of the boilers being a spare unit. The annual coal consumed will be about 4,000 tons.

(Please turn to next page)

Table I—Summary of Plant Costs

	Structures	Equipment	Total
Raw material handling		$22,000	$22,000
Raw material proportioning	$60,000	50,000	110,000
Electric furnace department	197,000	280,000	577,000
Phosphorus condensing and storage	17,000	284,000	301,000
Metaphosphate furnaces	20,000	190,000	210,000
Metaphosphate storage	165,000	14,000	179,000
Plant services	58,000	353,000	411,000
Office, laboratory, shop, and wash house	77,000	35,000	112,000
Yards and grounds		132,000	132,000
Subtotals	$594,000	$1,460,000	$2,054,000
Contingent items	59,000	146,000	205,000
Totals	$653,000	$1,606,000	$2,259,000
Real estate			11,000
			$2,270,000

Plant Cost and Amortization

The cost estimate for the proposed plant is summarized in Table I.

A large part of the total plant cost is in structures of concrete, steel, brick, protected metal and other materials having a relatively high first cost and a relatively long life. A depreciation rate of 4 per cent is assumed for such structures. At the other end of the scale are such items as furnace linings and parts of the plant where corrosion is so severe that depreciation disappears into annual repair and maintenance costs. The estimated costs of various types of structures and equipment, depreciation rates, and amortization cost is indicated in Table II.

Table II—Depreciation Rates and Costs

	Depreciation Rate—Per Cent	Capital Cost	Depreciation Cost
Liquor and gas pumps	20	$50,000	$10,000
Liquor piping	20	40,000	8,000
Condenser and auxiliaries	20	167,000	33,400
Tank silos, bins, etc.	10	30,000	3,000
Thickener	10	20,000	2,000
Monorail cars	10	6,000	600
Slag disposal	10	50,000	5,000
Electric furnaces	10	165,000	16,500
Metaphosphate furnaces	10	180,000	18,000
Tools and furniture	10	35,000	3,500
Conveyors and elevators	6.7	67,000	4,220
Cranes and cars	6.7	10,000	670
Boiler and auxiliaries	5	45,000	2,250
Water pumps and tanks	5	35,000	1,750
Motors and electrical equipment	5	550,000	27,500
Services lines and railroads	4	136,000	5,440
Buildings	4	653,000	26,120
Walks, roads, etc.	0	14,000	
		$3,259,000	$168,950

Cost of Raw Materials

Phosphate Nodules—A cost of $3.50 per net ton will be assumed for nodulized phosphate delivered to the plant from an adjacent nodulizing unit. This nodulizing plant, and the washing plant previously mentioned, are not considered in the present paper. The mining, washing, drying, and nodulizing or sintering of phosphate are operations which may be discussed in a later paper, but are omitted here. The cost of nodules assumed above is, however, based on a layout for a washing-nodulizing plant and a detailed consideration of the costs involved.

The annual cost for the 126,350 tons of nodules required would be $442,225.

Coke—Screened coke breeze may be purchased at $1.62 per net ton, at Birmingham. The freight to Middle Tennessee is $1.76, making a delivered cost of $3.38 per ton. This coke will be dried in the adjacent raw materials preparation plant. A drying cost of $0.30 is assumed, making a total cost of $3.68 per ton of coke. The tons of coke required per year is 21,000 and the annual cost of coke would be $77,280.

Lump Rock Phosphate—This material would be produced in the adjacent washing plant. A price of $4.75 per net ton for rock carrying 33 per cent P_2O_5 will be assumed. Washed lump rock may be purchased in Tennessee at this price. The cost of 28,600 tons would be $135,850.

Electrodes—In operation of the Tennessee Valley Authority's fertilizer works, an average of the monthly consumption of electrodes for eight months in 1937 and 1938 was 16.1 pounds per ton of P_2O_5 in the charge fed to the furnace. Based on this figure, the annual consumption of electrodes would be approximately 500,000 pounds. At 6-2/3 cents per pound the annual electrode cost would be $33,300.

Coal for Steam Plant—The cost of coal delivered at Sheffield, Alabama, is $3.25 per ton. The same cost will be assumed for a plant in Middle Tennessee. The annual coal bill would then be $13,000.

Materials for Repair and Maintenance—Experience to date indicates that the cost of this item used in previous article[2] i.e. $1.79 per ton of available P_2O_5 in the finished product, would not be exceeded. For 51,400 tons of metaphosphate carrying 66 per cent total P_2O_5, of which 99 per cent is available, the repairs and maintenance item would be $60,115.

Power—Power will be used at the rates specified in the power contract between the Tennessee Valley Authority and the Victor Chemical Co. for delivery at Mount Pleasant in Central Tennessee. In the absence of an actual measured demand, and specific data as to how long secondary power might be available in any given year, an annual power bill may be calculated only by assuming certain average conditions. This has been done in arriving at the following power costs based on operation of four furnaces, two for 300 days and two for 365 days a year:

100,000 kw.-hr. at 4 mills	$400
200,000 kw.-hr. at 3 mills	600
700,000 kw.-hr. at 2½ mills	1750
3,320,000 kw.-hr. at 2 mills	6640
4,420,000 kw.-hr. at 1.5 mills	6630
8,740,000 kw.-hr.—energy charge	$16,020
Demand: 12,000 kw. at $0.90	10,800
Monthly bill	$26,820
Annual bill	$321,840

The annual bill for secondary power would be:

$$300 \times \$0.06 \times 12{,}000 = \$216{,}000$$

and the total annual bill would be $537,840. For the 191,200,000 kw.-hr. which might be used, the average cost would be 2.81 mills per kw-hr.

Labor and Supervision

The supervision and labor required are summarized in Table III, which shows the number of men and the annual pay roll for each department. These estimates are based on present T.V.A. wage schedules.

Table III—Supervision and Labor Costs

	No. of Men	Annual Pay Roll
Office and laboratory	16	$31,200
Repairs and maintenance	57	95,320
Raw materials	16	18,480
Electric furnaces and condensers	83	110,300
Metaphosphate unit	27	33,280
Plant services	17	28,300
Total	216	$316,880

Miscellaneous Costs

Taxes—A county and state tax of 3½ per cent on a 50 per cent evaluation has been assumed. This is an annual cost of $39,725.

Social Security Tax—A social security tax amounting to 1½ per cent of the total pay roll is provided, making an annual cost of $4,753.

Insurance—The proposed plant is constructed of steel, brick, concrete, and other non-inflammable materials. There is no occasion for carrying fire insurance. Workmen's compensation insurance is taken at 2 per cent of the annual pay roll, amounting to $6,338.

First Aid and Incidental Medical Care—This is taken at 2 per cent of the annual pay roll, amountng to $6,338.

Storerdom Service—An item of $6,250 annually has been allowed for the cost of this service.

Interest—Interest is included at 5 per cent per annum, or $113,500.

Miscellaneous—An arbitrary charge of 5 cents per ton of metaphosphate produced has been allowed for miscellaneous small costs, or an annual sum of $2,570.

Credits to Production Costs

At $75 per gross ton, the annual value of the 4,770 net tons of ferrophos produced would be $357,750.

The carbon monoxide gas delivered to the adjacent nodulizing plant will be given a value of 5 cents per 1,000 cu. ft. The annual revenues from this sale would be $37,500.

Slag might be sold occasionally, but its sale is too uncertain for consideration as a source of income.

Total Production Cost

The production costs are summarized in Table IV. The total cost of $30.54 per ton of metaphosphate (66.0 per cent total P_2O_5, 65.4 per cent available P_2O_5), or $46.66 per ton of available P_2O_5, represents the cost in the storage pile.

In a previously published article[3] the cost of available P_2O_5 in the form of 50.5 per cent superphosphate was estimated to be $45.26 in the stock pile. This cost estimate and the present one for metaphosphate are not on the same basis in several respects. Salaries and wages have increased about 10 per cent since the previous estimate. A different power schedule has been set up. Interest was not included in the previous estimate. The selling price of ferrophosphorus has been advanced. Correcting for all of these changes, the corresponding cost of available P_2O_5 in the form of 50.5 per cent superphosphate would be approximately $50.65 per ton. The comparison with metaphosphate is then as follows:

	Total Cost per Ton	Total Cost per Ton Available P_2O_5
Superphosphate (50.5 per cent)	$25.60	$50.65
Metaphosphate (65.4 per cent)	30.54	46.66

To this must be added costs of recovery from the stock pile, grinding, screening, bagging, manufacturer's overhead and profit, state tax, freight, and dealers' profit, to arrive at a reasonable selling price.

Table IV—Summary of Production Cost

	Annual Cost	Cost per Ton Metaphosphate	Cost per Ton Available P_2O_5	Per Cent Total
Phosphate nodules	$442,225	$8.60	$13.15	22.50
Lump phosphate	135,850	2.64	4.04	6.91
Coke	77,280	1.50	2.29	3.93
Coal	13,000	.25	.38	.66
Power	537,840	10.46	16.00	27.37
Electrodes	33,300	.65	.99	1.70
Maintenance materials	60,115	1.17	1.79	3.06
Labor and supervision	316,880	6.16	9.42	16.13
Medical care	6,338	.12	.18	.32
Storeroom	6,250	.12	.18	.32
Depreciation	168,950	3.29	5.03	8.60
Property tax	39,725	.77	1.18	2.02
Social security tax	4,753	.09	.14	.24
Insurance	6,338	.12	.18	.32
Interest	113,500	2.21	3.38	5.78
Miscellaneous	2,750	.05	.08	.14
Total	$1,965,094	$38.20	$58.41	100.00
Credit, ferrophos	357,750	6.93	10.63	
Credit, gas	57,500	.73	1.12	
Net cost	$1,569,844	$30.54	$46.66	

ORGANIZATION and CONTROL

Basic Foundations for Profitable Chemical Processing

By W. I. McNEILL

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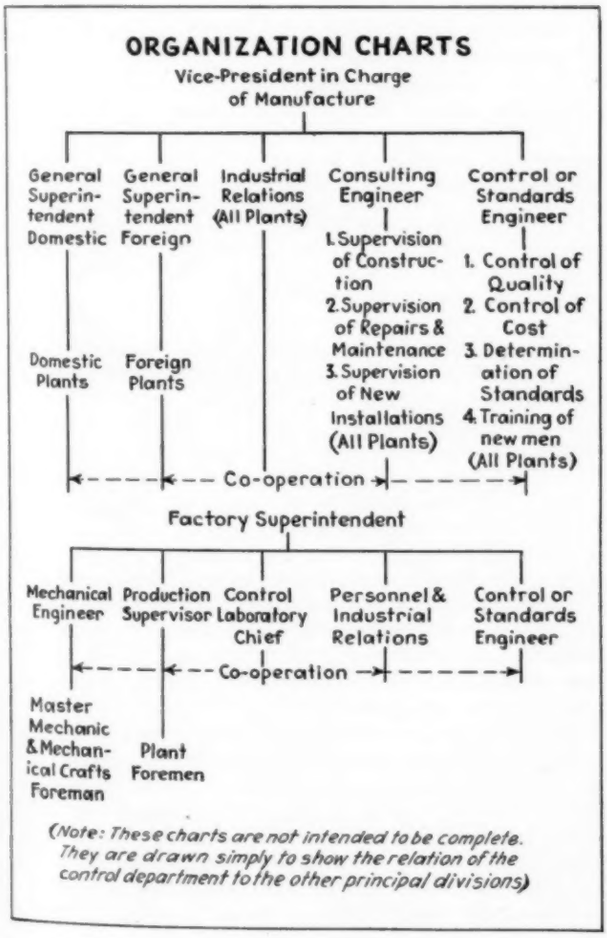
WE NO LONGER have expanding frontiers. Our population is not increasing as rapidly as in the past. Taxes are eating into profits. Government control is more strict. More concerns are after the available business. These are a few of the reasons why enlightened industrialists realize that in order to maintain profits in the face of an ever increasing competition, control over operations must be more strict.

The purpose of this article is, therefore, to outline a practical organization of manufacturing activities, together with methods for effectively controlling the quality and cost of products. The particular type of organization to be outlined is employed successfully, and profitably, by a number of concerns having widely separated plants. It combines, quite effectively, the training of new men in the organization with the study of plant problems. The control department, if correctly organized and wisely administered, will provide insurance whereby faulty operations will be spotted and corrected before the company's profits suffer appreciably. This plan of control, through the use of standards, is worth the money it costs even if it shows only that operations are as good as it is possible to make them.

If any plant is as efficient as it can be made (but few are), it is worth something for the management to know it and be able to prove it with facts. People are human, however, and eternal vigilance is necessary to maintain operations at standard. After operations have once been perfected and standardized, it is essential that the organization to keep them so be provided through an adequate system of control. Such a plan is outlined herewith.


ORGANIZATION CHARTS
Vice-President in Charge of Manufacture
General Superintendent Domestic
General Superintendent Foreign
Industrial Relations (All Plants)
Consulting Engineer
Control or Standards Engineer
1. Supervision of Construction
2. Supervision of Repairs & Maintenance
3. Supervision of New Installations (All Plants)
1. Control of Quality
2. Control of Cost
3. Determination of Standards
4. Training of new men (All Plants)
Domestic Plants
Foreign Plants
Co-operation
Factory Superintendent
Mechanical Engineer
Production Supervisor
Control Laboratory Chief
Personnel & Industrial Relations
Control or Standards Engineer
Co-operation
Master Mechanic & Mechanical Crafts Foreman
Plant Foremen
(Note: These charts are not intended to be complete. They are drawn simply to show the relation of the control department to the other principal divisions)

Organization

Any organization is only as good as its individual members. Hence, it is proper to preface the plan of organization with a brief outline of the characteristics of the type of men that should make it a success. These characteristics, stated in the order of their importance, are: (1) fundamental honesty and stability of character; (2) intelligence, ability to co-operate, general education; and (3) specific knowledge and capacity for the kind of work for which they are chosen.

The type of organization into which such men may be placed is shown in the accompanying charts. These charts are drawn for an organization with a number of operating units. Smaller organizations can adopt a modified form suitable to their needs.

A separate department is shown for carrying out the control of quality and cost. In a smaller organization with only one general superintendent, this department would be placed under the general superintendent since it really carries out one of his responsibilities in the same way that the industrial relations officer and mechanical engineer specialize in their particular phases of plant control. It is important to note that the local plant

control man is directly responsible to the plant superintendent and not to the headquarters staff control man. Contacts do take place directly between the headquarters and plant control men, but copies of all correspondence go to the local superintendent and to the general superintendent.

Some plant managers may feel that a separate department on control work is unnecessary. Experience has proved, however, that the superintendent, production supervisor, and foremen in any plant employing more than 300 people are so busy with production and labor problems, attending conferences with departmental heads, etc., that they do not have time to give thoughtful study to the control of operations. Certain things can be observed by passing through a department, but many losses, wastages, high costs, etc., only come to light through the intelligent study of facts and comparison with standards. There are more profit-making possibilities in the common sense analysis of costs than would appear on the surface.

It is essential that the control personnel be chosen for their combined knowledge of factory operations and cost procedures. Most manufacturing men have a limited knowledge of how costs are derived. Few could explain how depreciation is handled on the company's books or could tell how overhead is derived or distributed. On the other hand, relatively few accountants have a working knowledge of factory procedures or know how to talk costs in factory terms. And yet, most factory problems resolve themselves into a consideration of costs. It is vitally important to any concern that the control personnel be made up of people who are on a par with the operating personnel on the production side and who know enough cost accounting to understand the derivation of the figures. Engineers with cost accounting training make, in the writer's opinion, the most useful control men. Their training is also such that they may readily equip themselves for the broader administrative phases of plant operation. The factory control department is on a par with the production supervisor's department in furnishing candidates for the position of superintendent. A good administrator without long production experience is likely to be a better superintendent than a good production supervisor without broad administrative or control experience.

Control Department Functions

Briefly stated, the functions of the control department are as follows:

1. Control the quality and cost of production through the initiation, assembly and interpretation of production, laboratory and cost reports.
2. Originate investigations to determine why operations are not meeting standards for quality or cost.
3. Check all new formulas and set standards for quality and cost for all operations.
4. Direct the writing of standard practice instructions and be responsible for keeping them up-to-date at all times. These standard practice instructions should cover: (a) factory operations (including methods of sampling), and (b) laboratory methods (Note: If the control department does not originate these methods, it should at least be satisfied that such methods are coordinated with the general plan of control.)
5. Handle special studies affecting the economy of making changes in operating methods.

The method of control operates in a manner somewhat as follows:

1. Operating reports for both quality and cost are usually prepared by both the local plant cost department and the laboratory.
2. Copies are sent to: (a) local plant control department, (b) local plant production supervisor, (c) local plant superintendent, (d) general superintendent at headquarters, and (e) headquarters control department.
3. The local control department analyzes all reports and, after conferring with the superintendent, production supervisor and sometimes foreman, instigates investigations into all items that deviate from standard beyond allowable limits. It becomes a matter of judgment when an investigation is necessary. The money value of the deviation should be the deciding factor.
4. The headquarters control department and the general superintendent review the reports. The former summarizes the results in comparative form, by plants, either in the form of statistical sheets or graphs.
5. A weekly or monthly letter of comments is written by the local plant control department on each report. This letter points out the deviations from standards for quality and cost, explains the cause of the trouble, and tells what is being done about it.
6. Under ideal conditions, it should never be necessary for the headquarters control office to write any plant, calling attention to deviations from standard. In case, however, any branch plant is not always alert in solving its own problems, the headquarters control department acts as the second line of defense in maintaining good operation.
7. In addition to controlling operations, the headquarters control department compares the details of operation between plants and makes improvements in one plant available to all.

It is, of course, human for people to become negligent when engaged in the same task day in and day out. The very fact that each local control engineer is obliged to review his plant's operations at regular intervals and write comments about deviations from standards, makes the analysis of operations a routine affair. An additional inducement for thoroughness is the knowledge that if deviations are not caught locally, the local staff is quite certain to hear from headquarters.

In previous paragraphs the use of standards for both quality and cost have been mentioned. In any system of control, it is indispensable that standards be set by which actual results may be measured. Averages of past performance are of some value, but they may not tell how close an operation approximates the best performance. There are two classes of standards: standards for quality and standards for cost. The former cover the physical and chemical characteristics of the product at different stages of operation. These are often set by the department of development and research, cooperating with the sales department.

Standards for cost are determined by factory studies by means of which the most economical cost is determined for different volumes of production. A comparison of actual costs with standard costs indicates weak spots and shows how much money is involved. For instance, statements can be prepared, usually monthly, to show the following data for each department separately and for the plant as a whole.

Month of January — Operation No. 1

	Actual Dollars Spent	Standard Dollars	Difference
Productive labor	$150	$100	$50
Non-productive labor	50	40	10
Repairs and maintenance	30	20	10
Other variable expense	..	..	..
Total variable expense	$230	$160	$70

Note: A statement of this type usually includes all items of expense, both fixed and variable, with standards for all the controllable items.

If the difference between standard and actual dollars spent is large enough, an investigation should be made to determine where the difficulty lies. If the difference persists it may be desirable to keep daily records until the difficulty is discovered and corrected.

Supplementing the money standards are standards for yields, wastages, scrap and operating losses—also standard factors for the usage of steam, water, power, gas, etc. The latter group may be derived through special studies and through the use of meters and recording instruments.

The reader is aware that a cost system designed for factory control as well as for financial uses, is indispensable. Too often cost systems are designed for financial and accounting uses only. The factory needs a cost system the results of which will give it the control data it needs in terms that it can easily understand. Proper interpretation of costs may make or break a business. It is important, therefore, that costs be presented in simple, understandable terms.

An adequate cost plan should include a complete balance of materials from start to finish. In other words, every pound of material purchased should be accounted for either in finished production or inventories.

Analysis of Costs

A simple process cost account is given herewith, together with a statement showing the analysis of an operation in terms of 100 lb. The account indicates how the various cost elements, added to the original cost of materials, make up the unit cost of the finished product. This account follows:

Charges or Debits	Quantity (Lbs.)	Unit Price Per 100 Lbs.	Value
Received from process No. 1	150	$4.666	$7.00
Usage of chemical No. 1 (3 lb.)		10.000	0.30
Usage of chemical No. 2 (1 lb.)		3.000	0.03
Labor			0.05
Burden			0.12
Total	150	$5.00	$7.50
Usages or Credits			
Product made	137	5.255	7.20
Scrap (degraded)	10	3.00	0.30
Loss unaccounted for	3	....	....
Total	150	$5.00	$7.50

This is the kind of account available to the factory on all operations. The derivation of the unit costs from the account as presented is analyzed in a table below. This analysis indicates that, for the most part, chemicals No. 1 and No. 2 are consumed, but do not become a part of the product. They cost 20c. and 2c. per 100 lb. of product respectively. The degrading of scrap costs $0.146 while the loss costs $0.11. It might be possible to double the usage of chemical No. 2 and save half of the cost of degrading scrap. This would be profitable because of a saving of a net amount of $0.053 per 100 lb. An additional man on the job might increase the labor cost $0.01 and reduce the loss one-half or $0.055. Scrap might be utilized differently, resulting in only a part of the degrading cost. These are some of the interpretations that can be made if costs are properly prepared.

		Cost per 100 Lb.
Cost of material entering the process (either new or from another process)		$4.666
Cost effect (per 100 lb.) of:		
Chemical No. 1	$\frac{\$0.30}{150} \times 100 = \$.200$	
Chemical No. 2	$\frac{\$0.03}{150} \times 100 = 0.020$	
Labor	$\frac{\$0.05}{150} \times 100 = 0.033$	
Burden	$\frac{\$0.12}{150} \times 100 = 0.080$	
Loss	$\frac{3 \times \$0.05}{137} \times 100 = 0.110$	
Scrap	$\frac{10\ (\$0.05 - \$0.03)}{137} \times 100 = 0.146$	
Total operation cost		0.589
Final cost of product from this operation		$5.255

Training of New Men

So far, we have been concerned with organization and methods of control. One of the intangible benefits in a control program is in the opportunity it gives for training new men in the organization for future executive positions. There are now two ways for accomplishing this. One is the form employed by some concerns; namely, that of a sort of apprenticeship by means of which the apprentice is put on a definite job in a definite department for a length of time, then shifted to another job in another department until he has covered many of the jobs throughout the plant by actually doing the work. This is a long-time process in which the individual spends considerable time doing routine repetitive work.

The second and more recent method, which has proved successful, is to make the individual a part of the control organization. Problems for study are chosen by the plant control chief. They are usually active problems, such as deviations from cost standards, high scrap, losses, etc., the solution of which is of value to the company. The new individual becomes a collector of facts and, in so doing, he learns the intimate details of the department in which he is working. After the facts have been collected and the report written, the solution is very often self-evident even to the new individual. In all cases, the interpretation of the facts by the superintendent, assistant superintendent and others connected with the problem, aids the new employee in the solution of his problem. The foremen and workmen are taught to look on these young men as collectors of facts and not as "experts" who are going to tell them how to run their departments. Such a plan gets some value out of the services of the new man from the beginning, and, at the same time, gives the individual an interesting problem to work on. It is believed to be more valuable in effecting his training than the method first described.

Conclusion

It is to be expected that many who have not tried the plan of control outlined, may be skeptical of the added profits to be realized by its adoption. Since a number of leading concerns are successfully using this plan, it is at least worth investigating for any who may lack coordination between accounting and manufacturing, or who may be unable to locate the reason for unprofitable manufacture.

Hydrocarbons Converted to Fuel Gas by New Process

By J. A. GUYER
EXECUTIVE VICE PRESIDENT
J. P. DEVINE MANUFACTURING CO., INC.
MT. VERNON, ILL.

FUEL GAS can now be tailor-made to fit individual plant or domestic heating requirements. A new process developed and patented by the Phillips Petroleum Co. makes available fuel gases of definite specific gravity and heating value which may be varied over a wide range.

The HWG (hydrocarbon water gas) process, as it is commonly called, combines two fundamental reactions: thermal decomposition of hydrocarbon gases or vapors, and water gas reactions between hydrocarbons and steam. Thermal decomposition reactions have been extensively studied and are used commercially to produce olefins, other hydrocarbons, hydrogen and carbon. Water gas reactions between hydrocarbon vapors and steam have also been studied extensively, primarily for the purpose of producing low specific gravity gas to blend with natural gas or to produce a controlled B.t.u. value water gas for city distribution. Patents on the HWG process cover a novel form of catalyst, method of operation and operating conditions whereby these two reactions are carried on simultaneously in a high temperature furnace under definitely controlled conditions.

Herewith is a diagram of a proposed plant. The reaction is carried out in a modern type radiant heat tube furnace similar to the furnaces used to crack petroleum. Water, one of the raw materials, is preheated by a system of heat exchangers and waste heat boilers, utilizing both the sensible heat of the stack gases and that of the gas product. The other raw material, hydrocarbon gases or vapors, after careful metering and pressure regulating, is led into the steam pipe at the point of entry to the furnace. Upon passing over the catalyst this mixture of vapors is converted to HWG gas (composition shown in table) which is then led through a waste heat boiler, a cooler and water separator into the gas main.

Plants of this design can be built having capacities from 2,000 to 200,000 cu.ft. per hr. A simplified design is available for small plants with capacities from 200 to 2,000 cu.ft. per hr. A wide variation in raw material is possible, such as propane, butane, and other hydrocarbons found in refinery vapors.

Process Development

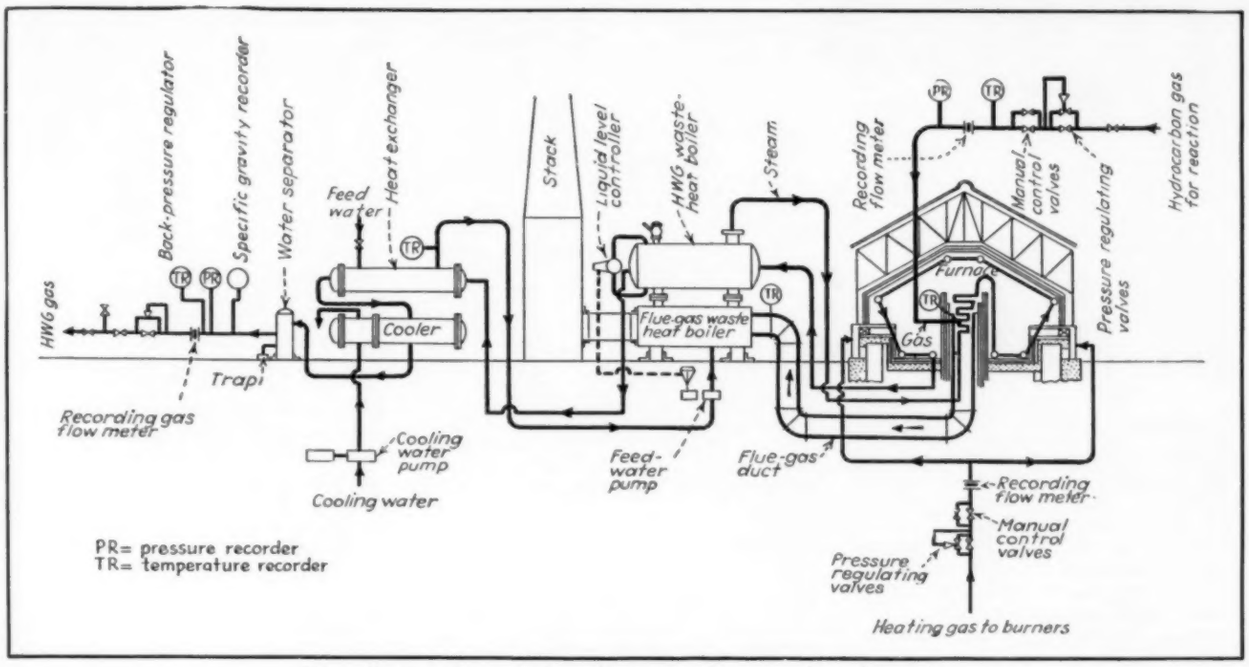
The effects of process variables such as reaction time, temperature, ratio of hydrocarbon vapor to steam, and type of catalyst, were studied for some time in the laboratory. Upon completion of the laboratory work, experimentation was continued in a pilot plant made from a semi-commercial size radiant heat tube furnace that had been previously used for development on the thermal decomposition of hydrocarbon vapors. The capacity of this furnace was about 7,500 cu.ft. of 600 B.t.u. gas per hour. After about two months of experimental work with the furnace, it was proved that laboratory data could be duplicated on a larger scale and that the physical form of the catalyst and method of introducing the gas stream mixture had even greater advantages in large scale operation than had been anticipated.

The next step was to design and build a pilot plant specifically for the process to obtain more accurate data. It had a capacity of 1,000 to 1,800 cu.ft. per hr., depending upon B.t.u. value and specific gravity of the gas produced. It was designed to permit very accurate control of all variables and to obtain the effect of changing each variable independently. Furthermore, industrial size recording flowmeters were used in the various gas lines. Tests were made using residue gas (predominately methane) from a natural gasoline plant, commercial butane, and other gases, as raw materials. Portions of the HWG gas were passed through a Cottrell electric precipitator to determine the amount of free carbon in the gas, if any. In no case was any free carbon found when operating under conditions within the range of commercial operations. Some of the data thus obtained are shown in Tables I and II.

This plant was operated continuously 24 hours a day, seven days a week, for about six months. At the end of this period, there was no noticeable decrease in the activity of the catalyst, and also the stainless steel tubes (18-8 low carbon showed no appreciable oxidation of the outside surface and no embrittlement.

Proposed Field of Usefulness

At the time this development work was done, the major objective was to obtain a gas suitable for blending with blue water gas, coal gas, or natural gas to produce a plant fuel gas of controlled heating value. Operating conditions could be controlled to produce a lower B.t.u. value and higher hydrogen content gas if desired. It has been found also that the specific gravity of the fuel can be very closely controlled. In addition to being useful in those processes which require a fuel having peculiar physical characteristics, the process may have a wide variety of possible applications in the domestic gas industry for: (1) meeting peak loads; (2) as a standby for other types of gas producing equipment; (3) as a method of reforming or adjusting the B.t.u. value of natural gas or refinery vapors to be used directly as fuel or as a blending gas; and (4) supplying gas needs of small communities.



Flow diagram for a hydrocarbon water gas manufacturing unit

Table I—Characteristics of fuel gas obtained by using steam and natural gas as raw materials. The natural gas used in this series of tests was a gasoline plant residue varying in specific gravity from 1.0 to 1.2

		Percentage Composition				
Spec. Grav.[1]	Heat Value, B.t.u.[2]	Carbon Dioxide	Carbon Monoxide	Hydrogen	Saturated Hydrocarbon	Unsaturated Hydrocarbon
0.39	393	7.0	14.9	57.5	18.5	2.1
0.41	422	7.4	13.5	54.9	22.6	1.6
0.43	510	6.8	12.5	51.4	26.9	2.4
0.45	570	6.3	10.5	43.6	37.2	2.4
0.46	554	8.0	11.2	51.0	27.5	2.3
0.49	540	6.2	13.3	50.4	26.1	4.0
0.65	624	5.5	7.3	36.2	47.0	4.0

[1]Specific gravity values by continuous recorder
[2]B.t.u. values by calorimeter

Table II—Specific gravity, heating value and analysis of fuel gas produced from steam and commercial butane. Values given are typical of tests taken at random. Capacity of pilot plant—1,500 cu. ft. per hr.

		Percentage Composition				
Spec. Grav.[1]	Heat Value, B.t.u.[2]	Carbon Dioxide	Carbon Monoxide	Hydrogen	Saturated Hydrocarbon	Unsaturated Hydrocarbon
0.44	474	7.0	17.0	55.8	14.4	5.8
0.48	538	6.6	15.6	54.6	15.4	7.8
0.50	572	6.0	15.7	53.3	15.4	9.6
0.52	585	4.6	16.3	50.2	18.3	10.6
0.55	613	6.2	13.7	51.1	17.7	11.3
0.58	702	4.1	13.7	47.2	20.2	14.8
0.61	808	5.2	12.1	44.9	20.6	17.2
0.65	822	5.8	13.0	47.2	21.4	12.6

[1]Specific gravity values by continuous recorder
[2]B.t.u. values by calorimeter

New Corrosion-Proof Coating

A NEW protective coating for concrete, wood, and metal surfaces, has been developed under the direction of Francis L. Carson, of the American Concrete and Steel Pipe Co. of South Gate, Calif. It differs from other synthetic plastic base coatings in that the type of solvents used and the manner in which the fillers and pigments are used are new. The material does not contain oil; consequently, it is not subject to the changes and deteriorations found in oil-bearing coatings. The basis of this corrosion-resistant material is a combination of synthetic organic plastics.

In October 1935 sizable pieces of concrete, that had been coated with this plastic coating, Amercoat, were immersed in sulphuric, hydrochloric, nitric, acetic, hydrofluoric and many other commercial acids of concentrations from 5 to 20 per cent. Like specimens were immersed in solutions of all the commercial alkalis, in gasoline, benzine, distillate, oils of various viscosities, greases, and many other known corrosive solutions. Today, after more than two and one-half years of immersion, no evidence of attack can be found on the coatings, yet in many of the solutions the concrete has become disintegrated or been completely destroyed.

Not being satisfied with such evidence and in an effort to find the material's useful limits, one of the major oil companies saw fit to run the coating through their own testing and research laboratories. They found that it would resist sodium hydroxide up to 40 per cent concentration at 212 deg. F. for a 7-hr. period. They also subjected the material to sulphuric acid 95 per cent concentrated at 212 deg. F. for seven hours and found some evidence of blistering, but otherwise the coating seemed to be unharmed.

Examination of coated tanks after some nine months in service on fishing boats where they are alternately filled with fuel and fish, shows the material to be impervious to severe exposure and sufficiently plastic not to check, crack or shatter from vibration or thermal expansion and contraction of the steel.

Chemical Engineer's BOOKSHELF

New Titles and Authors

COLLOID STUDY

COLLOID SYSTEMS—A SURVEY OF THE PHENOMENA OF MODERN COLLOID PHYSICS AND CHEMISTRY. By *A. Von Buzagh*. Translated by O. B. Darbishire. Edited by William Clayton. Published by The Technical Press, Ltd., London, England. American agent, Reinhold Publishing Co., New York City. 296 pages. Price, $9.

Reviewed by *W. L. Abramowitz*

AS THE author states in his preface, colloid chemistry or physics, once "the science of neglected dimensions," has become in two short decades "the science of not-to-be-neglected dimensions." Defining colloids roughly as matter having at least one dimension between 0.0005 and 0.000001 mm., it is evident that a considerable domain of our world falls within that range. As industrial examples, one need but mention proteins as gelatin or casein, clays, rubber latex, soaps and other detergents, wetting agents, emulsions-cosmetics, paper and textile sizes, lubricants and coatings.

Unfortunately (or perhaps fortunately) colloid systems are so complex that even at present the available knowledge is largely empirical and uncorrelated. Clayton's "Theory of Emulsions and Their Technical Treatment" remains the factual bible. The present volume presents the theoretical concepts as developed principally by the Ostwald school. Colloidal systems are defined, their characteristics described and the forces (both stabilizing and disruptive) acting between and upon them studied.

The book is not of outstanding importance to the industrial chemist unless he is a specialist in colloids.

REPORT OF THE BULK PACKAGING SESSIONS OF THE EIGHTH PACKAGING CONFERENCE. Published by the American Management Association, 330 W. 42d St., New York City. 95 pages mimeographed. Price, $1.25.

CONSTRUCTION, loading and staying of wooden barrels and steel drums are covered in six of the eleven papers comprising this symposium. The remainder are devoted to the manufacture, filling and weighing of paper and textile bags. The discussion pertaining to each of the papers is included.

GAS PROCEEDINGS

PROCEEDINGS, 1937, AMERICAN GAS ASSOCIATION. Published by American Gas Association, Inc., 420 Lexington Ave., New York City. 848 pages. Price, to members, $3; nonmembers, $7.

THIS ANNUAL VOLUME, which publishes the convention proceedings of A.G.A., affords the usual valuable composite of technical and industrial articles which are nowhere else available in complete compact form. Many of the subjects covered by the manuscripts presented at the technical sessions deserve attention by any chemical engineers interested in fuel or fuel processing.

SULPHURIC ACID ECONOMICS

THE ECONOMICS OF THE SULPHURIC ACID INDUSTRY. By *Theodore J. Kreps*. Published by the Stanford University Press, Stanford University, Calif. 284 pages. Price, $5.

THIS VOLUME, the first of a contemplated series of four dealing with chemical economics, is the outcome of a program undertaken by the author in 1926 at the advice and under the direction of Prof. F. W. Taussig of Harvard. This program was followed intensively at that university until 1931, and since then at Stanford University where Mr. Kreps is now associate professor of business economics in the Graduate School of Business. Extensive personal contact with chemical industry throughout the world, coupled with official representation of the United States at Geneva in the conference on reduction of hours in the chemical industry, in 1936, and the conference of the International Labor Office in 1937, have given Professor Kreps an exceedingly broad outlook on chemical industry problems. Aside from this, his study of source material has been minutely exhaustive and his documentation painstaking. The result is a book that is accurate in fact, authoritative in opinion, and still highly readable. Sulphuric acid exhibits a fascinating economic history as it unrolls beneath the author's expert pen.

Following an excellent historical section, Mr. Krebs undertakes the consideration of the industry from the standpoint of competitive situations: the competition of processes, of raw materials, of different acid producing industries, of producing areas, of companies, and of materials which can be substituted for sulphuric acid. Likewise he considers the problem of joint costs and the competitive importance of labor. Although readers may not agree with all of the author's conclusions, they will find no other comparable source of information from which their own conclusions can be drawn with assurance that essential data have not escaped consideration.

NEW ANALYTICAL METHODS

NEWER METHODS OF VOLUMETRIC CHEMICAL ANALYSIS. By *Erna Brennecke, N. Howell Furman, Hellmuth Stamm, Rudolph Lang,* and *Kasimir Fajans*. Edited by Wilhelm Böttger. Published by D. Van Nostrand Co., Inc., New York City. 268 pages. Price, $3.75.

Reviewed by *C. S. Sherman*

THIS WORK was originally published in German in 1935 as the 33rd volume in the series of "Monographs on Analytical Chemistry," founded by B. M. Margosches. The present volume, translated by Ralph E. Oesper, is based on a second revised German edition in which some of the chapters were rewritten, literature references were brought up to date, and a new chapter on alkaline permanganate was added.

The book is a concise, workable summary of the "newer methods," and now that an American edition is available it will probably enjoy a wider use in this country than did the original edition in German. Each of the seven parts of the book is competently and authoritatively discussed by a specialist in the field, and is treated with two objectives in mind: "(a) exposition of the theory underlying the new method, so that an insight may be gained into the reasons for the way the subject has been developed, and (b) the presentation, as far as possible, of an exact set of directions for the performance of particular analyses."

The book covers its subject thoroughly and completely. It is a presentation and discussion of the *newer* methods of volumetric analysis, and as such must not be considered as merely "another book" in the analytical field, but should be accepted by the experienced analyst as an aid to greater appreciation of the progress made in recent years in the development of rapid, accurate volumetric methods. It may

serve also to introduce some of these newer methods not only as time-savers for the hard-pressed industrial analyst, but as means whereby the tedium and difficulties of some of the older methods may be avoided.

PAPER MAKERS GUIDE

MANUFACTURE OF PULP AND PAPER, VOL. IV: RAGS, WASTE PAPERS, BEATING, LOADING, SIZING, COLORING, MILL EQUIPMENT. Third Edition. Published by McGraw-Hill Book Co., New York, N. Y. and London, England. 794 pages. Price, $6.50.

THIS STANDARD TEXT and reference book has been completely revised and enlarged under the direction of the Joint Textbook Committee of the Paper Industry of the United States and Canada. It covers the subjects of preparation and cooking of rags, waste papers, and fibers other than wood, and of beating, loading, sizing and coloring of paper stocks, and of general mill equipment. A major change has been made by bringing the chapter on tub sizing forward from a later volume and combining it with the chapter on engine sizing in this volume, thus making a single section on the sizing of paper. The sections on beating and refining, sizing, fillers and loading, paper coloring, heating and ventilation, water, and lubrication have been rewritten. The remainder of the volume has been corrected and brought up-to-date, and much new material has been added regarding new equipment for preparing esparto grass, refining, and the like, and additional data on electric steam generators and new pumps.

The committee in charge of preparation carefully selected the outstanding authorities in the United States and Canada to write on the various phases of pulp and paper making covered in this volume. Over 30 engineers took part in the work under the editorial guidance of J. N. Stephenson.

MICRO TECHNIQUES

SEMI-MICRO QUALITATIVE ANALYSIS. By *Paul Arthur* and *Otto M. Smith*. Published by the McGraw-Hill Book Co., New York City. 198 pages. Price, $2.

Reviewed by *Raymond J. F. Kunz*

EFFECTIVELY ACHIEVED in this text is the objective stated by the author in his preface: to present a system of micro qualitative analysis in such a manner as to make it clear, easily understood, and as far as possible self-administering.

The scheme follows the usual macro procedure, differing only in the technique employed. Semi-micro methods and the construction of the necessary simple apparatus are clearly described, and a brief review of the fundamental principles of analysis is included. Advanced students will find profitable the discussion of four organic reagents commonly used in analytical work. The techniques are described clearly and concisely, and for use where the regular procedures are not clear cut, a number of auxiliary tests are given.

Although written as a text for students in second year chemistry, the methods of semi-micro analysis outlined should be valuable in any analytical laboratory.

THE TECHNICAL ANALYSIS OF ORES AND METALLURGICAL PRODUCTS. By *Franklin G. Hills*. Published by the Chemical Publishing Co., New York, N. Y. 198 pages. Price, $3.

THE DETECTION of 29 of the more common elements occurring in from large to minute amounts in metals and metallurgical ores is covered in this book. The author gives the accepted method of analysis for each particular substance, and follows this with a discussion of interfering elements and suggestions as to why certain methods are desirable in special cases.

GAS PLANT COMPANIONS

ANALYTISCHE METHODEN UND TABELLEN FUER DIE UEBERWACHUNG UND DEN BETRIEB DER BENZOLFABRIK VON KOKEREIEN UND GASWERKEN. By *A. Jenker*. Published by Wilhelm Knapp, Halle (Saale), Germany. 95 pages. Price, RM 5.48.

THE OBJECT of this little handbook is to enable the engineer in charge of producing gas washing oil, benzol, naphthas, and other products of coke plants and gas works, to obtain maximum efficiency in each of his processes. The best analytical and control methods are assembled and described, generally in sufficient completeness to render recourse to the literature unnecessary. This is of particular value inasmuch as the literature on the subject is scattered widely. Numerous tables on vapor pressures, specific heats, standard specifications and other essential data are included.

LABORATORIUMSBUCH FUER GASWERKE UND GASBETRIEBE ALLER ART, TEIL I. By *F. Schuster*. Published by Wilhelm Knapp, Halle (Saale), Germany. 155 pages. Price, RM 8.70.

THIS VOLUME may be considered a companion handbook to the one reviewed immediately above. It covers the analytical procedures for testing solid and liquid fuels for gas plants, and the products thereof. Insofar as the control of the naphtha fractions are included (phenol, naphthalene, etc.) there is some overlapping between the two books. The present one is divided into two parts, presenting comprehensively in the first half the physical and chemical methods for analyzing the wood, peat, lignite, and the various coals used, and the cokes, tars and pitches produced. The second half deals with the production and analysis of ammonia liquors and with phenol and general aromatics determinations. A supplementary volume later will deal with gaseous fuels.

AIR CONDITIONING TEXT

TRANE AIR CONDITIONING MANUAL. By *William Goodman*. Published by The Trane Co., La Crosse, Wis. 333 pages. Price, $5.

Reviewed by *T. R. Olive*

TO AN ENGINEER who has long had an intellectual if not a professional interest in air conditioning, this new manual is a revelation in clarity, simplicity and completeness. Published as it was by a manufacturer of air conditioning equipment, it would not be surprising if it had exhibited at least a visible bias in the case of controversial questions, or if some suggestion of plugging the manufacturer's own products had crept in. All the more credit is due, therefore, to Mr. Goodman and others in the Trane engineering and research departments who assisted him, in that not one word of advertising has been admitted to the discussion. Although the book is eminently practical, it preserves an admirable and academic impartiality, treating the subject in a broad and fundamental way. To those engineers who desire an expert working knowledge of this rapidly growing industry, the book would seem to be essential.

First the author briefly covers the fundamentals of heat and fluid properties, then in carefully prepared sections, clarified at every step by worked-out practical problems, treats heat gains and the passage of heat through building elements. At this point he takes up the properties of air and it is in this section and in the following discussion of air conditioning calculations that his genius for instruction is shown to best advantage. A new and simplified psychrometric chart is introduced which, together with a specially designed ruler, greatly facilitates the handling of air conditioning problems and by graphical means makes calculation largely unnecessary.

The remainder of the book is given over to exhaustive discussions of refrigeration and water for air conditioning, with much information on such relatively new phases of the problem as evaporative condensers, steam jet coolers and ice for air conditioning. Certain subjects such as duct design, air filters, heat producing equipment and sound control have been omitted in favor of existing handbooks and texts, but very little that is essential to a full understanding of air conditioning proper is missing.

CANCER FROM COAL TAR

THE CAUSE OF CANCER. By *David Brownlie*. Published by Chapman and Hall, Ltd., London, England. 208 pages. Price, 7s. 6d.

Reviewed by *R. G. Gustavson*

THE AUTHOR, a fuel technologist, reviews the work of E. L. Kennaway and his associates at the London Cancer Hospital Research Institute, who have shown that cancer may be produced at will by the injection into rats of certain aromatic hydrocarbons such as 1:2 benzanthracene and 1:2 benzpyrene. The author's theory is that traces of dangerous cancer-causing higher hydrocarbons are present in tar and gas made by the high temperature carbonization of coal at over 1292—1472 deg. F., and that the higher the carbonization temperature the more poisonous the gas and the tar.

The author is convinced that the death rate from cancer has grown steadily during the last seventy-five years. This increase has taken place in spite of the advances made in the elimination of unsanitary conditions and the opportunities available for a healthier existence. The author does not discuss the possibility that our healthier environment today may be responsible for our longer life period, which places a greater number of individuals in the age group where they are susceptible to cancer.

The author believes that the wide spread distribution of carbonized material from coal tar on roads, gases made by the destructive distillation of coal as well as direct contact with tar and tar products is the cause of the increase in cancer.

The book is not critical; it is definitely propagandistic in tone, but it is worth reading because it calls attention to possible causes of cancer which every coal tar industry should carefully consider.

THE CRYSTALLINE STATE

CRYSTAL CHEMISTRY. By *Charles W. Stillwell*. Published by the McGraw-Hill Book Co., New York City. 431 pages. Price, $4.50.

Reviewed by *Eugene Goddess*

THIS REVIEWER was in that group of students with whom "the author started, some six years ago at the University of Illinois, to devote two weeks of the introductory course in general chemistry to the presentation of these fundamental ideas" of crystal chemistry. The full effectiveness of Dr. Stillwell's classroom teaching has been carried over into the pages of this new book.

The volume is quite complete in its treatment of the general conceptions, but has avoided drowning the meat of the subject in a mass of ponderous detail. Of general interest are the numerous examples of applications of crystal chemistry to everyday life, such as the explanation of why wet wool can be stretched more than dry wool, why rubber is elastic and cotton is not, why oils are classed as fibers, why diamonds are colorless, why lead and gold differ in color, and finally—the why of a permanent wave. Not to be confused with a popular treatment of a scientific subject, Dr. Stillwell's amply illustrated work is a fully technical examination of a subject seemingly destined to greater importance in the chemical world.

HANDBUCH DER METALLBEIZEREI — NICHTEISENMETALLE. By *Otto Vogel*. Published by Verlag Chemie, G.m.b.H., Berlin W35. 262 pages. Price, RM $16.50.

THE general and practical aspects of the operations of pickling, soaking, cleaning and etching of non-ferrous metals are covered here in an exceptionally complete manner. The greater part of the text is devoted to industrial methods with extensive descriptions of equipment. There is also considerable material on recovery and regenerative systems for acids and solvents.

WAHL HANDYBOOK OF THE AMERICAN BREWING INDUSTRY, VOL. 1, BEER—FROM THE EXPERTS'S VIEWPOINT. By *Arnold F. Wahl* and *Robert Wahl*. Published by Wahl Institute, Inc., Chicago, Ill. 509 pages.

BEER-MAKING as an art is the subject of this first of four volumes which have been written to replace the widely used pre-prohibition *Wahl-Henius Handy Book of the Brewing, Malting and Auxiliary Trades*. The book is of an introductory nature and covers broadly the history, types, and properties of beer; the brewing process; the flavor of beer; legal relations; and social considerations.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Ball-Mill Grinding, by Will H. Coghill and Fred D. Devaney. Bureau of Mines, Technical Paper 581; 15 cents.

Crushing and Grinding, by John Gross. Bureau of Mines, Bulletin 402; 25 cents.

Primary Crushing, Progress Report No. 3, by Mark Sheppard. Bureau of Mines, Report of investigation 3390; mimeographed.

Determination of the Swelling Properties of Coal During the Coking Process, by H. S. Auvil and J. D. Davis. Bureau of Mines, Report of Investigations 3403; mimeographed.

Dewatering and Drying of Coal, by James R. Cudworth and Ellis S. Hertzog. Bureau of Mines, Information Circular 7009; mimeographed.

Marketing Mica, by Paul M. Tyler. Bureau of Mines, Information Circular 6997: mimeographed.

Marketing Clay, by Paul M. Tyler. Bureau of Mines, Information Circular 6998; mimeographed.

Treatment and Sale of Black Sands, by M. W. von Bernewitz. Bureau of Mines, Information Circular 7000; mimeographed.

Laboratories that Make Assays, Analyses, and Tests on Ores, Minerals, and other Substances, by C. W. Davis and M. W. von Bernewitz. Bureau of Mines, Information Circular 6999; mimeographed.

Résumé of Problems Relating to Edge-Water Encroachment in Oil Sands, by F. G. Miller and H. C. Miller. Bureau of Mines, Report of Investigations 3392; mimeographed.

Disposal of Petroleum Wastes on Oil-Producing Properties, by Ludwig Schmidt and C. J. Wilhelm. Bureau of Mines, Report of Investigations 3394; mimeographed.

Calibration of Positive-Displacement Oil Meters, by R. E. Heithecker and W. B. Berwald. Bureau of Mines, Report of Investigations 3396; mimeographed.

Flow Characteristics, Composition, and Some Liquid-Phase Properties of Hydrocarbon Fluids From a "Combination" Well, by C. K. Eilerts and M. A. Schellhardt. Bureau of Mines, Report of Investigations 3402; mimeographed.

Mineral production statistics for 1937, preliminary mimeographed statements from Bureau of Mines, are now available. The final data in printed pamphlet form, preprints of Minerals Yearbook 1938, are beginning to appear. Those issued thus far are: chromite; magnesite and other magnesium compounds; asbestos. 5 cents each.

Fats and Oils Trade of the United States in 1937, by Charles E. Lund. Bureau of Foreign and Domestic Commerce, mimeographed preliminary statistics.

Composition and Fractionation of American Steam-Distilled Wood Turpentine, by S. Palkin, T. C. Chadwick, and M. B. Matlack. Department of Agriculture, Technical Bulletin 596; 5 cents.

Rubber Content and Habits of a Second Desert Milkweed (Asclepias Erosa) *of Southern California and Arizona*, by R. E. Beckett, R. S. Stitt, and E. N. Duncan. Department of Agriculture, Technical Bulletin 604; 5 cents.

Deterioration of Paper as Indicated by Gas Chamber Tests, by T. D. Jarrell, J. M. Hankins, and F. P. Veitch. Department of Agriculture, Technical Bulletin 605; 5 cents.

Influence of Farm Manure on Yields and Sucrose of Sugar Beets, by Stephen H. Hastings, S. B. Nuckols, and Lionel Harris. Department of Agriculture, Technical Bulletin 614; 5 cents.

Annual Report on Tobacco Statistics, 1937. Department of Agriculture, Statistical Bulletin 63; 15 cents.

Insect Enemies of Western Forests, by F. P. Keen. Department of Agriculture, Miscellaneous Publication 273; 25 cents.

Animal Glues: Their Manufacture, Testing, and Preparation. Mimeographed summary by Forest Products Laboratory, Madison, Wis.

Vegetable (Starch) Glue, by Don Brouse. Mimeographed summary of Forest Products Laboratory, Madison, Wis.

State Labor Legislation, 1937, including workmen's compensation legislation, 1938. Bureau of Labor Statistics, Bulletin 654; 10 cents.

State Labor Laws for Women, Part I—Summary, by Florence P. Smith. Department of Labor Women's Bureau, Bulletin 156; 5 cents.

Occupational Disease Legislation in the United States, 1936, with appendix for 1937. Bureau of Labor Statistics, Bulletin 652; 15 cents.

Proceedings of the Fourth National Conference on Labor Legislation, Washington, D. C., October, 1937. Division of Labor Standards, Bulletin 18; 20 cents.

Causes and Prevention of Accidents in the Fertilizer Industry, 1936, by Max D. Kossoris and Swen Kjaer. Bureau of Labor Statistics, Serial R, 713.

A study of Dust Control Methods in an Asbestos Fabricating Plant, by Richard T. Page and J. J. Bloomfield. Public Health Service, Reprint No. 1883; 10 cents.

Process Equipment NEWS

Machinery, Materials and Products

Industrial Spotlight

BENJAMIN ELECTRIC MFG. CO., Des Plaines, Ill., has recently announced a new industrial spotlight known as the Benjamin Intensifier, designed to supply high intensity illumination of approximately 1,000 foot candles over a restricted area. To eliminate glare, dead black internal louvers are provided. Sizes range from 60 to 500 watts. Glass covers in both plain and daylight glass are available. This equipment is suggested for use in illuminating the inside of ovens, dryers and other process machinery.

Multiple Tray Clarifier

WHAT IS SAID to be a new design principle is incorporated in the Seip Multi-Tray clarifier recently announced by the Graver Tank & Mfg. Co., East Chicago, Ind. The clarifier employs from one to as many as seven round, inverted trays, supported by brackets attached to the inner side of the tank shell. The intake to the compartments formed by the trays is at the periphery and the clear liquid is discharged at the top of each chamber, near the central shaft which carries scrapers supported immediately above each tray. Deposited solids discharge at the periphery. Solids deposited from the inward flowing liquid collect on top of the trays and are said to function as an entangling medium for light-weight particles which otherwise would not settle quickly.

The new clarifier is built for both hot and cold liquids and is furnished complete with vertical tank and fittings; or it can be accommodated to any existing tank.

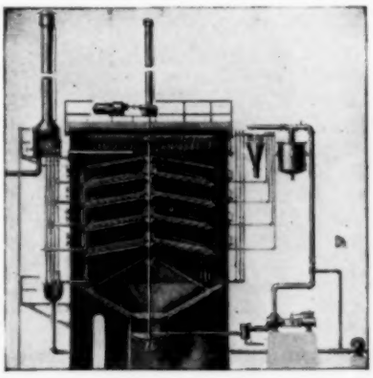
Self-Priming Pump

AN ACCOMPANYING VIEW shows a new pumping unit combining a centrifugal pump and priming tank, adaptable to full automatic control, which has recently been put on the market under the name of Hazleton-Auto-Pump by Barrett, Haentjens & Co., Hazleton, Pa. Only part of the air handled during the priming period passes through the pump, the greater part being expelled from the priming tank directly into the discharge line. This tank retains sufficient water to prime a short suction line but repeated starts are necessary to prime long lines. Once primed, the pump is stated to hold its prime for days since it is under pressure and cannot draw in air when standing idle. Six sizes are available, ranging from 1 to 15 hp., with the pump made in any desired metal or alloy.

Pipe Weld Preheater

FOR USE in the welding of alloy metal pipe, the Detroit Electric Furnace Co., Detroit, Mich., has developed an electric heater which can be used to preheat pipe before welding and during the welding operation, without manual adjustment of the heating element. Any temperature up to 600 deg. F. can be maintained during welding, according to the manufacturer. The equipment includes an indicating pyrometer, a two-heat switch and an arrangement of adjustable heating elements held in direct contact with the pipe. Insulating blankets are provided to insulate the heating apparatus from the welder, without inconveniencing him at his work. The apparatus requires less than 30 kw. for operation and has been designed to supplement this company's previously announced induction stress reliever for high-temperature, high-pressure welded joints.

Cross-section of Multi-Tray clarifier



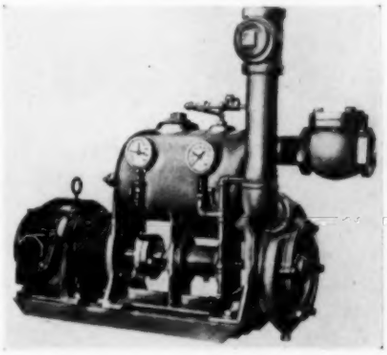
High Ratio Reducers

D. O. JAMES MFG. CO., 1114 West Monroe St., Chicago, Ill., announces the development of three new sizes of double-type worm-gear reducers with a large range of speed ratios, from 30 to 3,600 to 1, having torque capacities at the slow speed shaft from 40 inch pounds to 400 inch pounds. Two bronze worm gears and steel worms mounted on Timken bearings give a light drive with high ratios.

Equipment Briefs

SIMPLER, quicker and more economical closing of kegs and barrels is said to be the accomplishment of the new Campbell-Burgess stapler recently announced by the Burgess Co., Beaver

New Hazleton-Auto-Pump



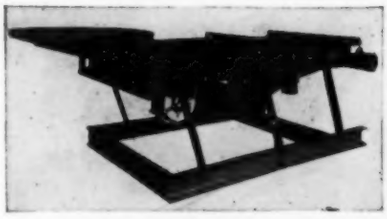
Electric preheater for pipe welding

Falls, Pa. This device, which can be handled by one man, uses a special cam action to drive nail-pointed staples completely through the hoop and staves of the barrel into the head, by means of a single motion of the lever handle. Staples come in strips of 25, cohered for easy loading into the magazine. Through use of this machine it is claimed that heads and hoops can be re-used, heads cannot be splintered, nails cannot be dropped into the barrel contents, and much quicker work can be done.

DEVELOPED originally for use in its own plant is a new system of lighting recently announced by the United Cinephone Corp., 43 Thirty-Third St., Long Island City, N. Y. This system, Ortho-Plane lighting, makes use of a succession of seven plane reflectors so set as to reflect seven planes of light at different calculated angles and produce even illumination of the desired area. It is claimed that the efficiency is considerably greater than that of curved reflectors, that there is 50 per cent less shadow and no glare. Units are regularly available in aluminum finish, but may be secured in black or other finishes to special order.

INTRODUCTION of a new light-weight ball bearing belt conveyor carrier, designed to be supported on two parallel pipes instead of the conventional structural steel stringers, has been announced by Stephens-Adamson Mfg. Co., Aurora, Ill. Since the carrier brackets are clamped to the pipes without boring holes, carriers can be shifted whenever necessary. A rocker type mounting permits the carrier to tilt in either direction with travel of the belt, and in this way, even a reversible direction belt is accurately centered at all times, according to the manufacturer. Permanently sealed cartridge type ball bearings are used on the three carrier rollers, which are inclined to trough the belt at 20 deg. for maximum capacity and greatest belt life.

THREE STAGES of air cleaning in a curtain type filter which is said to be non-clogging, are provided in the new "armored" Multi-Panel air filter recently announced by American Air Filter Co., Louisville, Ky. The new filter panel is a combination of woven screen and a die-stamped louver section. The louver section consists of closely spaced vertical streamline-shaped baffles and forms the exposed area of the panel. The upper part of the woven screen section is Bakelite-fiber coated for high efficiency in fine dust removal, while the lower part is left uncoated to provide a second or intermediate stage of air cleaning. Coarse particles are collected on the "armored" section of the filter curtain. Panels are cleaned by movement through an oil bath, this action being facilitated by the added weight of the armored section which accelerates the movement of the panel, actively forcing oil through the screen. The new panel is interchangeable with former types of all-screen panels and earlier Multi-Panel filters.



Flat-bed vibrating screen

TO PROVIDE a line of medium-sized, self-powered, air and gas compressors for refineries, air-lift pumping, refrigeration and general compressor service, the Worthington Pump & Machinery Corp., Harrison, N. J., has developed and announced the Type LCE unit which comprises in each size a four-cycle gas engine driving a compressor. Sizes range from 1 to 4 compressor cylinders, with twice as many power cylinders. Compressor cylinders are horizontal and at right angles to the power cylinders. Sizes range from 75 to 300 hp. Insofar as possible, parts are made interchangeable so as to eliminate the necessity for carrying a large stock of replacements. For example, engine and compressor connecting rods are identical and interchangeable.

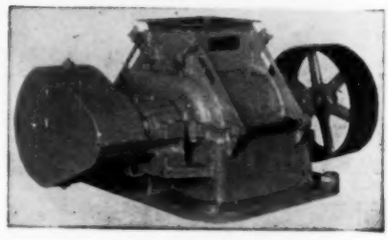
Vibrating Screen

DESIGNED for minimum headroom, a new flat vibrating screen equipped with the Ajax-Shaler shaker has recently been announced by the Ajax Flexible Coupling Co., Westfield, N. Y. The shaker operates without eccentrics and is said to impart a smooth reciprocating action to the screen. The screening compartment and drive unit are completely inclosed in dirt- and oil-tight housings. Speeds and stroke lengths are variable to suit the requirements of various materials. Power of 1 hp. or less is required, depending on the screen size.

Gas Alarm

FOR TESTING and warning of dangerous concentrations of gases such as hydrogen sulphide, B. O. Bushnell, 541 North Kings Road, Los Angeles, Calif., has recently introduced the R & B automatic gas detector and alarm. The complete equipment including the gas detector and alarm, remote control equipment and the gas gathering system occupies a floor space of 4x6 ft. The equipment automatically gathers samples from as many as 15 places, continuously indicates the strength of the samples and gives an alarm with sound and light whenever the gases are of sufficient strength to constitute a hazard. It can also be used to start blowers or other ventilating equipment. The instrument is self-cleaning before and after each sample. Distribution is being handled by E. D. Bullard Co., 275 Eighth St., San Francisco, Calif.

Detector and alarm for hazardous gases



New saw tooth crusher

Saw Tooth Crusher

READY OPENING for cleaning is a principal feature of an improved design of saw tooth crusher recently announced by Sprout, Waldron & Co., Muncy, Pa. Two hinged sections are readily opened by loosening two wing nut clamps, thus exposing the two crushing rolls to full view. Either roller or plain bearings can be used and crushing cylinders may be supplied in lengths from 10 to 25 in. The crushing rolls are equipped with saw tooth disks of hardened steel, having either 8 or 16 points. The crusher handles material up to 6 in. in thickness, reducing to 1½ or ¾ in. depending on the type of toothed disk used.

Temperature Controller

BURLING INSTRUMENT Co., 241 Springfield Ave., Newark, N. J., has announced production of a new two- or three-step electric temperature controller known as Model VD-2. In this instrument the temperature sensitive element is made of alloys said to be resistant to corrosion and to temperatures higher than that for which the instrument is designed. Two snap-action switches, each of which is individually adjustable, are provided for translating movements of the sensitive element into control impulses. Either switch may be normally closed, nor-

Process Equipment NEWS

Dilecto pipe ends

mally opened, or of the single-pole, double-throw type, so that many variations of temperature control circuits can be worked out. This controller is suitable for temperatures from 0 to 1,400 deg. F.

Molded Pipe Ends

DILECTO PIPE ENDS, a new product of the Continental-Diamond Fibre Co., Newark, Del., are a molded laminated plastic product of high electrical insulating properties and good mechanical strength, said to be unaffected by water, steam and chemicals or adverse temperatures, and designed to prevent dangerous grounds. They are made in two styles—one threaded for standard pipe and conduit threads, and the other plain with three set screws for fastening. Sizes range from ½ to 4 in.

New Products

TWO NEW wetting-out and penetrating agents, Penetrol-60 and Penetrol-65, have been announced by The Beacon Co., 89 Bickford St., Boston, Mass. These materials, which are stated to be of use in many industries where the more expensive sulphonated alcohols are not economical, are particularly recommended by the manufacturer for application in the paper industry for removal of ink from old paper, manufacture of absorbing papers, etc.; in the textile and leather industries; in metal cleaning and pickling compounds; and in agricultural sprays. Number 60 is the more efficient while No. 65 is somewhat slower acting but lower in cost.

DESCRIBED as entirely new, the Neville Co., Neville Island, Pittsburgh, Pa., has brought out Neville 465 resin, an inexpensive, dark colored synthetic material which is suggested for use in such products as printing inks, adhesives, mastic tile, linoleum, varnishes and rubber compounds. It is soluble in a variety of common solvents, insoluble in water, and compatible with tars, pitches, rosin and most natural and synthetic resins. The physical properties are similar to those of this company's coumarone-indene resins, although the chemical properties are quite different.

A LINE of metal protective paints recently announced by the Sherwin-Williams Co., Cleveland, Ohio, has been put on the market under the name of Kem-Metal protective paints. For the finish coat Kem-Elastic metal protective paint is provided, while for priming either Kem red lead or Kem-Kromik metal primer may be used. The latter contains lead chromate as an inhibitor. These materials are formulated with synthetic Kem liquid which is said to confer more complete exclusion of water and gases from the metal protected, greater durability, and improved appearance. Fast drying and easy brushing are claimed as important features. A special primer is available for zinc.

TWO RECENT developments of General Plastics, Inc., North Tonawanda, N. Y., include No. 5116 resin adhesive and No. 2274 molding compound. The former material, which is said to be unaffected by water, moderate heat, mild acids and alkalis, is suggested especially for bonding such materials as asbestos to steel, rubber to metal, plastic molded parts, porcelain enameled parts, and Cellophane to steel, copper or wood. The new molding compound was developed for use in molded parts with especially large inserts subject to extremes of temperature. Cracking is avoided by the use of a slightly flexible compound.

ORGANIC MATERIALS recently announced by the Röhm & Haas Co., 222 West Washington Sq., Philadelphia, Pa., include a new tertiary amine, Hyamine A, and anhydrous trimethylamine and its aqueous solutions. Hyamine A forms water-soluble salts, is essentially nonvolatile and is amphoteric. It is said to be particularly useful in the preparation of emulsions, creams, pastes and cosmetics. The trimethylamine is produced by an improved process which is claimed to make this material the cheapest organic base now available. Having a purity close to 98 per cent, the material is recommended particularly for saponification of oils, fats and waxes, and for the synthesis of such materials as accelerators, antiseptics and pharmaceuticals.

INERTNESS to gasoline, oils and organic solvents is an important feature of Resistoflex, a flexible synthetic resin which is now being manufactured in the United States at the Dover, N. J., plant of Resistoflex Corp., 370 Lexington Ave., New York, N. Y. This material, basically polyvinyl alcohol, is said to be exceptionally tough, resistant to pressure, of good elasticity, and a good absorber of vibration. At present it is being made in the form of tubing in diameters ranging up to ½ in. I. D. It will later be available in the form of sheets, gaskets, washers, packing and diaphragm materials. The material is stated to have been used successfully abroad for a number of years in many industrial applications.

U-Bolt Gate Valve

MADE IN SIZES from ¼ to 4 in., a new U-bolt gate valve is being offered by The Fairbanks Co., 393 Lafayette St., New York City, particularly for service in the chemical, paper, gas and petroleum industries. The new valve can be repacked under pressure and features a double-taper wedge gate with a knife edge at the bottom which is claimed to cut through heavy fluids and sediments, forcing foreign matter from the bottom of the wedge chamber into the line. Another feature is the provision of relief slots in the threaded bonnet bushing to permit drainage back into the body chamber so as to avoid freezing or clogging above the bonnet thread. The valves are designed for 150 lb. steam pressure or 225 lb. gas or liquid pressure.

MANUFACTURERS' LATEST PUBLICATIONS

Air Conditioning. Carrier Corp., Syracuse, N. Y.—Catalog 468A—32 pages on this company's heat diffusers for unit heating, with information on construction, dimensions and engineering data; also Bulletin 53B-1, 8 pages, describing this company's silica gel dehydrators for humidity control.

Air Filters. Independent Air Filter Co., 228 North LaSalle St., Chicago, Ill.—Bulletin P-405-16—12 pages describing this company's flameproof throw-away air filters, with engineering data.

Alloys. Allegheny Steel Co., Brackenridge, Pa.—12-page booklet, "As the World Sees Allegheny Metal," portraying the wide variety of applications of this material.

Alloys. International Nickel Co., 67 Wall St., New York City—16-page booklet describing the characteristics and uses of Monel, nickel and special alloys such as Inconel, K, S and R Monel. Also 8-page folder describing the use of Monel metal for gaskets, pump parts and valve trim.

Alloys. United States Steel Corp., Pittsburgh, Pa.—53-page book, "The Fabrication of U.S.S. Stainless Steels, Part I," dealing in considerable detail with the welding, riveting and soldering of joints, and with joint design. Covers various types of welding and required heat-treating operations.

Apparatus. American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.—Bulletin 1055—Describes a new portable refrigerating unit for use in the cooling of tanks and baths to be held at a

temperature constant to plus or minus 1 deg. C.

Apparatus. Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.—Leaflet describing this company's new Titrimeter with cathode ray "eye" for end point determination.

A.S.M.E. Code. Edge Moor Iron Works, 30 Rockefeller Plaza, New York City—Leaflet briefly summarizing construction specifications for unfired pressure vessels as set forth in the A.S.M.E. Code, paragraphs U-68, U-69, and U-70.

Chemicals. Glyco Products Co., 148 Lafayette St., New York City—Series of leaflets describing water-soluble resins, synthetic waxes, emulsifying agents, foam reducers and flameproofing materials.

Chemicals. Hercules Powder Co., Wilmington, Del.—Wall chart describing this company's six raw materials for protective coatings, with information on physical, electrical, mechanical and chemical properties.

Coatings. Truscon Laboratories, Caniff & G. T. R. R., Detroit, Mich.—12-page book describing application of StoneTex for the preservation of brick and concrete construction.

Compressors. Sullivan Machinery Co., Woodland Ave., Michigan City, Ind.—Bulletin A-12-A—Describes and illustrates Class WG-7 single-stage horizontal compressors for heavy duty in sizes from 40 to 125 hp.

Construction Materials. Resistoflex Corp., 370 Lexington Ave., New York City—8-page folder describing Resistoflex synthetic resin construction materials for hose and other equipment for the handling of solvents, petroleum hydrocarbons and other materials injurious to rubber.

Containers. Wheeling Corrugating Co., Wheeling, W. Va.—16-page book describing steel shipping containers made by this company; also leaflets covering pails and drums for oils, paints and similar materials.

Conveyors. Cyclone Fence Co., Waukegan, Ill.—Information on this company's metal conveyor belts, including an 8-page catalog and a 6-page folder, with information on weave, advantages and applications.

Corrosion. Mutual Chemical Co. of America, 270 Madison Ave., New York City—8-page booklet on the use of chromium chemicals as corrosion inhibitors, with information on uses in a variety of industries.

Diatoms. Johns-Manville, 22 East 40th St., New York City—24-page reprint of an article describing the properties, production and uses of diatomaceous earth, with added information on this company's filter aids.

Dust Collectors. Northern Blower Co., West 65th St. south of Denison, Cleveland, Ohio—4-page leaflet with engineering data describing this company's screen type dust arresters.

Dust Collectors. Western Precipitation Co., 1016 West Ninth St., Los Angeles, Calif.—24-page 25th anniversary booklet outlining this company's history and illustrating its present facilities and manufacturing, largely by pictures.

Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Publications as follows: Bulletin 1145B, 16 pages on metal-clad switchgear; 1156A, 20 pages on polyphase induction motors; 1165A, 16 pages on bracket-bearing synchronous motors.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—Publications as follows: GEA-19H, a.c. magnetic motor starting switch; GEA-841H, a.c. magnetic switch for induction motors; GEA-1750D, a.c. arc welders; GES-1841, 4 pages on instruments in industry; GEA-1929A, illustrates a variety of applications of this company's gear-motors; GEA-2234B, manual motor starting switches; GEA-2292A, magnetic crane control; GEA-2630, dew-point potentiometers; GEA-2679A, photoelectric relays; GEA-2742, 24 pages on Pyranol capacitors; GEA-2908, oil-proof push button selector switches.

Electrical Equipment. H-B Electric Co., 2518 North Broad St., Philadelphia, Pa.—4-page leaflet describing a new mercury plunger switch or relay recently developed by this company.

Engines. Worthington Pump & Machinery Corp., Harrison, N. J.—Bulletin S-500-B13—36 pages on a variety of diesel and gas engines in sizes to 1,800 hp. with information on a variety of installations.

Equipment. Combustion Engineering Co., 200 Madison Ave., New York City—8-page booklet describing this company's facilities for producing pressure vessels and fabricated plate work.

Equipment. Haveg Corp., Newark, Del.—Bulletin C-1—8 pages describing standard towers and accessories fabricated from Haveg; also Bulletin O-1, 12 pages on Haveg corrosion-resisting equipment with information on corrosion resistance.

Equipment. Struthers-Wells Division, Struthers-Wells Titusville Corp., Warren, Pa.—18-page book illustrating a wide variety of process industry equipment fabricated by this company. Also Bulletin 15, 16 pages with illustrations and engineering data on this company's mixers and autoclaves.

Equipment. Vitreous Steel Products Co., Cleveland, Ohio—12-page booklet on acid-resisting porcelain-enameled equipment supplied by this company, including such items as drying trays, cascade pans, containers, conveyor buckets, calender rolls and enameled screens.

Expansion Joints. E. B. Badger & Sons Co., Boston, Mass.—Bulletin 200—8 pages describing a variety of corrugated type expansion joints, with engineering data; also Bulletin 300, covering flexible seals for pipe lines.

Fire Protection. Walter Kidde & Co., 140 Cedar St., New York City—Bulletin D-481—4 pages on this company's carbon dioxide portable fire extinguishing equipment, with information on types and auxiliaries.

Fittings. Bonney Forge & Tool Works, Allentown, Pa.—Bulletin WT28—4 pages describing this company's Weldolet and Thredolet welding fittings for attachment of pipe.

Flooring. Ralph V. Rulon, Inc., Hunting Park Ave. at E St., Philadelphia, Pa.—Folder briefly describing advantages of asphahlt mastic floors as produced by this company.

Furnaces. Geo. P. Reintjes Co., 2517 Jefferson St., Kansas City, Mo.—Bulletin 301—16 pages describing in detail the company's methods of constructing furnace walls and arches.

Furnaces. W. S. Rockwell Co., 50 Church St., New York City.—Catalog 380—Leaflet describing this company's gas conditioning units for producing protective atmospheres for use in furnaces.

Furnaces. Harold E. Trent Co., 618 North 54th St., Philadelphia, Pa.—Leaflet 26TB—4 pages on a variety of electric furnaces made by this company.

Heating. Gorton Heating Corp., Cranford, N. J.—Bulletin 106—4-page bulletin describing this company's high pressure automatic air eliminator for use on steam heated dryers, steam coils, unit heaters and jacketed process equipment.

Instruments. Bacharach Industrial Instrument Co., 7000 Bennett St., Homewood Station, Pittsburgh, Pa.—Publications as follows: Bulletin 299, 4 pages on the Ardometer radiation pyrometer; Bulletin 300, 8 pages on this company's optical pyrometer; Bulletin 301, leaflet on the portable Ardometer.

Instruments. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio—Bulletin 46—32 pages on the company's boiler meter with information on its use and analysis of a large number of boiler tests showing how meters may be used in securing optimum results.

Instruments. Baldwin-Southwark Corp., Paschall P. O., Philadelphia, Pa.—Bulletin 140—16 pages on stress-strain recorders and extensometers for the investigation of construction materials.

Instruments. The Bristol Co., Waterbury, Conn.—Bulletin 506—Covers instruments for remote control; Bulletin 507, describes this company's round-chart potentiometers; Bulletin 488, 12 pages on millivoltmeter pyrometers.

Instruments. Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.—Folder 94-1—4 pages describing this company's pneumatic remote transmission system for measuring and control instruments.

Instruments. Fischer & Porter Co., 110 West Penn St., Germantown, Philadelphia, Pa.—Bulletin 102—24 pages describing this company's rotameter fluid meters with information on construction of tapered glass tubes, dimensions, types of rotameters, materials handled, capacities, and prices.

Instruments. The Foxboro Co., Foxboro, Mass.—Bulletin 193-3—8 pages describing this company's indicating pyrometers, Bulletin 217-1, 8 pages on controlled pneumatic loading methods for applying pressure or tension; Bulletin 223, 20 pages on this company's instrument boards, describing designs and materials.

Instruments. Wm. Hiergesell & Sons, 295 Pearl St., New York City—Bulletin 203—8 pages with price list covering this company's mercurial thermometers; also describes hydrometers.

Instruments. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.—Catalog N-57-161—20-page catalog describing this company's electrical frequency recorders and indicators.

Instruments. Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.—Bulletin 3010—44 pages on this company's pressure recorders, and recording and indicating thermometers, describing construction and accessories.

Instruments. The Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.—4-page leaflet briefly illustrating and describing this company's range of automatic controls for industrial use.

Instruments. Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa.—Bulletin 18-R (Supplement 1)—4-page booklet describing this company's universal rotameter flowmeter with information on design and a chart showing 16 different piping connections possible with this instrument.

Instruments. Simplex Valve & Meter Co., 68th and Upland Sts., Philadelphia, Pa.—Bulletin 54—4 pages describing this company's rate-of-flow controllers for vertical effluent lines; and air-operated filter gages.

Instruments. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.—Bulletin 1173—4 pages describing a new Celectray indicating controller for the throttling control of furnaces and ovens.

Instruments. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Bulletin B-2136—20 pages describing a variety of socket-type "plug-in" electrical instruments.

Instruments. Wilkens-Anderson Co., 111 North Canal St., Chicago, Ill.—4-page bulletin describing this company's Cameron glass electrode pH recorder; also 4-page bulletin describing the Cameron pH meter and its electrodes.

Insulation. Armstrong Cork Products Co., Building Materials Division, Lancaster, Pa.—A. I. A. File 37-B-4—40 pages

on this company's corkboard insulation for walls and floors, with information on heat transmission, condensation, and methods of application.

Jets. Worthington Pump & Machinery Corp., Harrison, N. J.—Bulletins W-205-B4 and W-205-B5—Describe in detail this company's improved line of two-stage condensing type single- and double-element steam-jet ejectors with surface type inter- and after-condensers.

Lead. American Smelting & Refining Co., 120 Broadway, New York City—24-page catalog on lead sheet and pipe for the chemical and acid industries, with information on types, facilities of the company, properties of various leads, data on pipe size and a considerable section giving conversion tables and other useful information.

Lubrication. American Chain & Cable Co., York, Pa.—4-page folder describing this company's Acco-Morrow pressure lubricator for use without special fittings.

Materials Handling. C. O. Bartlett & Snow Co., Cleveland, Ohio—Bulletin 80—24 pages on this company's anti-friction-bearing belt-conveyor idlers with information on prices and engineering data.

Materials Handling. The Fairbanks Co., 24 East 4th St., New York City—Catalog 51—24 pages describing a wide variety of hand trucks made by this company.

Materials Handling. Palmer-Bee Co., Detroit, Mich.—96-page catalog on roller conveyors covering types and capacities from 60 to 12,000 lb. with information permitting users to make suitable selections.

Materials Handling. Wellman Engineering Co., Cleveland, Ohio—Catalog of individual bulletins describing a variety of heavy materials handling equipment including several types of buckets, draglines and dredging equipment.

Mixing. Ransome Concrete Machinery Co., Industrial Division, Dunellen, N. J.—Bulletin 503—20 pages on rotary industrial mixers for fertilizers, glass batch, insecticides, plastics, and a wide variety of other process materials.

Packings. Crane Packing Co., 1800 Cuyler Ave., Chicago, Ill.—4-page folder describing this company's packings for pumps and valves for use in the petroleum industry.

Packings. Linear Packing & Rubber Co., State Rd. and Levick St., Tacony, Philadelphia, Pa.—Manual and data book on mechanical packings, designed to enable the user to select the kind and type best suited to his reqvirements.

Paints. The Skybryte Co., Cleveland, Ohio.—16-page catalog on coatings for metal, concrete, wood, glass and composition surfaces. Emphasizes value of color in producing desired psychological reactions.

Pipe Equipment. The Walworth Co., 50 East 42d St., New York City—Catalog 80—602-page catalog covering this company's complete line of valves, fittings, pipes and tools. Contains many added features.

Piping. A. M. Byers Co., Pittsburgh, Pa.—40-page engineering bulletin on the use of wrought iron for piping systems, with information on various piping materials, on relative costs of piping materials, on pipe selection, on corrosion and its effects and on performance records under a variety of conditions. Methods for reducing corrosion are listed.

Plating. E. I. du Pont de Nemours & Co., Wilmington, Del.—12-page technical service bulletin on the sodium stannate-acetate electrotinning process with information on preparation, control and analysis of the solution. Also new technical service manual of 12 pages on Cadalyte 38 for cadmium plating.

Plastics. Bakelite Corp., 247 Park Ave., New York City—16-page booklet describing in detail various applications of Bakelite plastics for such uses as cast and molded products, finishes and adhesives.

Power Transmission. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1266—12 pages describing this company's new Vari-Pitch speed changer.

Power Transmission. Farrel-Birmingham Co., Ansonia, Conn.—Catalog 438—80 pages on this company's speed-reducing and -increasing gear units and related products.

Power Transmission. Hydraulic Coupling Division, American Blower Corp., 632 Fisher Building, Detroit, Mich.—16-page bulletin describing this company's hydraulic variable-speed couplings, with information on principles, construction, performance and use.

Power Transmission. D. O. James Mfg. Co., 1114 West Monroe St., Chicago, Ill.—176-page speed reducer catalog No. 150, with information on a variety of worm, herringbone, spiral-bevel and spur-gear speed reducers.

Power Transmission. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill.—Data Book 1757—174 pages giving practical information, applications, pictures and engineering data on this company's "Silverlink" roller chain, with tables on sprocket wheels and useful information.

Power Transmission. Reeves Pulley Co., Columbus, Ind.—4-page leaflet describing a variety of inclosed variable-speed transmissions and their lubrication systems.

Pumps. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1651A—50 pages on all types of centrifugal pumps made by this company, with descriptions of installations, and engineering data.

Pumps. Ingersoll-Rand Co., 11 Broadway, New York City—Bulletin 7067—16 pages on this company's Cameron two-stage centrifugal pumps in capacities to 2,200 g.p.m.; also Bulletin 7069, 16 pages on end-suction centrifugal pumps in capacities to 1,000 g.p.m.

Pumps. Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass.—Bulletin 201-2—4 pages with specifications and engineering data on double-suction horizontally split centrifugal pumps.

Pumps. Quimby Pump Co., 340 Thomas St., Newark, N. J.—Publications as follows: Bulletin C-106-A, 4 pages on multi-stage centrifugal pumps; C-209, 12 pages on vertical centrifugal pumps; C-213, 4 pages on end-suction centrifugal pumps; C-104-A, 8 pages on construction and operation of screw pumps.

Pumps. A. R. Wilfley & Sons, Box 2230, Denver, Colo.—Bulletin E-1400—4 pages briefly describing construction features of this company's centrifugal sand pumps without stuffing boxes; also leaflet E-1415, 6 pages, describing this company's close-coupled and direct- and belt-driven centrifugal acid pumps.

Refractories. General Refractories Co., Philadelphia, Pa.—12-page booklet on the reduction of spalling through the use of high-duty refractories, giving charts, tests, and general information on three types.

Refractories. Ironton Fire Brick Co., Ironton, Ohio—4-page leaflet describing this company's fire brick for boiler settings, furnace and other linings.

Refractories. Quigley Co., 56 West 45th St., New York City—Bulletin 327-B—8 pages on this company's refractory insulating lagging for temperatures to 2,200 deg. F., showing properties and uses.

Roofs. Federal-American Cement Tile Co., 608 South Dearborn St., Chicago, Ill.—Catalog 103—48 pages on this company's light-weight concrete insulating slabs for roof construction, with information on a variety of applications, and a collection of engineering detail sheets.

Roofs. Johns-Manville, 22 East 40th St., New York City—35 page book describing in detail this company's complete built-up roof service, with information on performance records and specifications.

Rubber. Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.—Bulletin 6868—Describes functions and construction of this company's whipcord V-belts with information on prices and installations; also large instruction card giving information on unpacking, using and storing of rubber hose.

Separation. E. I. du Pont de Nemours & Co., Wilmington, Del.—12-page technical bulletin prepared by Minerals Separation Division of R. & H. Chemicals Dept., dealing with the sink-and-float process for the beneficiation of coal and minerals with complete information descriptive of an actual plant installation and appendix tabulating specific gravity data on a variety of minerals.

Separators. Dings Magnetic Separator Co., Milwaukee, Wis.—Catalog 770—Deals with this company's high intensity induction magnetic separators and crossbelt separators, with information also included on other types of machine made by this company. Also Catalog 22, 16 pages, describing in detail and illustrating applications of this company's high-intensity lifting magnets.

Size Reduction. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1815-D—8 pages describing and listing data on this company's crushing rolls.

Strainers. White Machine Works, P. O. Box 270, Fort Wayne, Ind.—Bulletin 25—4 pages describing and listing prices on this company's screens, foot valves and strainers for pumps.

Turbines. DeLaval Steam Turbine Co., Trenton, N. J.—Catalog C—20-pages illustrating and describing this company's velocity-stage steam turbines for driving auxiliary machinery.

Valves. Chemical Equipment Corp., Montpelier, Ind.—4-page leaflet describing this company's various valves designed especially for chemical industry use.

Valves. Hancock Valve Division, Manning, Maxwell & Moore, Bridgeport, Conn.—Bulletin 5-7000—16 pages on a variety of forged and cast steel valves including globe, angle and check types.

Valves. William Powell Co., Cincinnati, Ohio—26 pages covering a variety of special corrosion resisting alloy valves, with information on properties and uses of a variety of special materials used for valves.

Water Treatment. W. H. & L. D. Betz, 235 West Wyoming Ave., Philadelphia, Pa.—Reprint of an article on acid and reactive colloids for cooling-water treatment.

Water Treatment. D. W. Haering & Co., 340 West Monroe St., Chicago, Ill.—24-page booklet reprinting a series of articles dealing with corrosion control in a variety of water using systems.

Welding. Lincoln Electric Co., Cleveland, Ohio—4-page folder describing this company's diesel-driven 300-amp. arc welder.

Welding. Metal & Thermit Corp., 120 Broadway, New York City—Bulletin 20—12 pages on the arc welding of high-pressure, high-temperature piping with information on welded designs, welding procedure, and the selection of pipe materials and welding electrodes.

Wood Equipment. National Tank & Pipe Co., Portland, Ore.—275-page wood pipe handbook giving information on hydraulics, manufacture and application of wood pipe; Catalog 37 on wood tanks, giving information on tank construction and foundation design.

Chemical Engineering NEWS

SOLAR POWER INVESTIGATION ANNOUNCED BY M.I.T.

A comprehensive study of the economics and practice of converting solar energy to useful forms, which will be carried on for at least 50 years, will be started soon at the Massachusetts Institute of Technology, according to a recent announcement made by Dr. Karl T. Compton, president of the Institute. The undertaking was made possible by a gift of $647,700 from Dr. Godfrey L. Cabot of Boston whose long-continued interest in solar power utilization has taken this concrete method of expression. A similar gift to Harvard last year will be used in the investigation of methods for increasing the storage rate of solar energy in plants, while the work at M.I.T. will have as its object the study and development of direct physical and chemical methods for accomplishing solar energy conversion.

Through these two programs it is expected that all important avenues toward the efficient application of the inexhaustible supplies of solar energy will be subjected to thorough scrutiny, with the possibility that it may at present be found feasible to apply solar energy in certain areas or by certain processes, and with the definite object of developing energy sources against the time when our present fuel supplies will have dwindled. Investigations will be carried out by students in the departments of chemical engineering and chemistry, physics, electrical and mechanical engineering, under the direction of faculty members. To assist in formulating the program a committee has been appointed consisting of Professors H. C. Hottel (chemical engineering), A. C. Hardy (physics), E. H. Huntress (chemistry), A. R. von Hippel (electrical engineering), and G. W. Swett (mechanical engineering).

Silica Product Developed In West Virginia

An experimental factory has been established at Greer, W. Va., for the production of a new product known as silica black. It is a residue obtained when a mixture of about equal weights of finely pulverized bituminous coal and a finely ground siliceous material such as diatomaceous earth is subjected to destructive distillation. The amorphous carbon produced from the volatile products in the coal, deposits in and around the silica particles and adheres so tenaciously that a long period of heating in air is required to burn it out. The material is ground and air floated to approximately a one micron particle size.

Dr. C. A. Jacobson, professor of chemistry at West Virginia, worked for several years in the development of silica black and in conjunction with West Virginia industrialists, formed the Silica Black Products Co. which is operating the experimental factory in order to furnish working samples to companies which are developing industrial uses for the product.

Research Institute Formed At New York

As the result of a factual survey which indicated a need for an organization of industrial research executives so that they might have an opportunity to discuss common problems relating to laboratory organization and administration, and other technical matters bearing on industrial research, the Industrial Research Institute has been formed.

Scientific research men from many fields of industry are members of the Institute which was formed following a number of preliminary meetings at the Engineers' Club, New York.

Maurice Holland, Director of the National Research Council's Division of Engineering and Industrial Research, will act as executive officer of the Institute and the technical resources of the Division will be made available to the Institute during the organization stage.

Members of the executive committee are: Robert P. Colgate, vice-president of the Colgate-Palmolive-Peet Company, Jersey City, chairman; H. W. Graham, metallurgist for the Jones & Laughlin Steel Corporation, Pittsburgh, vice-chairman; O. A. Pickett, research director for the Hercules Powder Company, Wilmington; Oliver Kamm, scientific director for Parke, Davis & Co., Detroit; Donald Bradner, research director for Champion Paper & Fiber Company, Hamilton, Ohio; H. Earl Hoover, vice-president of the Hoover Company, Chicago; J. M. Wells, vice-president of the American Optical Company, Southbridge, Mass.; G. E. Hopkins, technical director for the Bigelow-Sanford Carpet Company, Thompsonville, Conn.

New High for Carbon Black Production Last Year

Advances in production and total sales and a slump in prices in the latter part of the year were important developments recorded by the carbon black industry last year according to a report from the Bureau of Mines. Production was 510,606,000 lb. a gain of 24 per cent over the previous peak reached in 1936. In the latter part of the year sales dropped because of a slowing up in the rubber trade and stocks held by producers increased to 100,497,000 lb. by the end of the year as compared with 79,582,000 lb. at the end of 1936. Sales reached a total of 489,615,000 lb. against 467,736,000 lb. in 1936. Exports increased from 154,718,000 lb. in 1936 to 184,030,000 lb. in 1937, hence domestic sales decreased from 313,018,000 lb. in 1936 to 305,585,000 lb. in 1937. Domestic sales were divided: 269,807,000 lb. to rubber companies, 18,116,000 to ink companies, 6,159,000 to paint companies, and 11,503,000 lb. to miscellaneous industries.

New Synthetic Base for Flysprays Developed

A new synthetic base for flysprays, non-toxic to humans and non-staining on fabrics and wallpaper, is announced by E. I. du Pont de Nemours & Co. of Wilmington, Del. The new product is known as isobutyl undecylenamide, an alcohol derivative combined with a vegetable oil derivative, and was developed in the du Pont laboratories for use by flyspray manufacturers in combination with pyrethrum extract.

M.C.A. Container Study Promises Savings in Millions

Editorial Staff Report

When two hundred executives of chemical industry met at Skytop, Pa., June 2 and 3 for the 66th annual meeting of the Manufacturing Chemists' Assn., they received definite evidence of the economic importance of the work of their technical committees on shipping containers. On display were samples of the new returnable steel drum recently approved by the Interstate Commerce Commission for the transportation of volatile solvents. By substituting twenty-gage steel for the former eighteen-gage body the new drum weighs 9½ lb. less than the old I.C.C. 5E drum and it is conservatively estimated that this will result in an annual savings of over $1,000,000 in the customers' freight bills. In addition there is an estimated savings of twenty to twenty-five cents in the construction of the drums. Since there is a normal production of about 8,000,000 containers of this type, it is evident that the potential saving to the industry is indeed tremendous. These and other equally interesting facts featured the annual report of the executive committee presented by its chairman, Harry L. Derby, president of American Cyanamid and Chemical Corp. The exhaustive tests which were made with the new drum will be described in an article to appear in the July issue of *Chem. & Met.*

President E. M. Allen presided at the business session where interesting reports were presented on reciprocal trade agreements, employer-employee relations and the business and political outlooks. At the union dinner with the members of the Synthetic Organic Chemical Manufacturers Assn., the guest speaker was the Hon. Bainbridge Colby, former Secretary of State in the Wilson administration.

In his comment on the reciprocal trade agreements, Mr. Derby reported that "from the viewpoint of the chemical industry as a whole, it is believed that the benefits received have not compensated for the concessions granted by the United States to foreign countries. It is important to emphasize that the indirect effects of these agreements are more important to the chemical industry than the actual direct effects from a reduction in chemical rates in the Tariff Act of 1930. That is to say, concessions granted by the United States resulting in increased imports of textiles, ceramics, leather, and other products into which chemicals enter as raw materials, curtail the home market for the output of the American chemical industry."

He also urged the industry to continue the public relations work it has begun and called attention to the Association's enterprise in distributing a large number of copies the "Facts and Figures of the American Chemical Industry" which was published as a supplement to the September issue of *Chem. & Met.* The Committee expressed the hope that a fact and figures book could be prepared and issued on a biennial basis.

All officers of the Association were re-elected for the coming year and it was announced that the Washington staff of Secretary Warren N. Watson, was to be increased by the appointment of M. F. Crass, Jr., to serve as his assistant. Mr. Crass is a chemical engineering graduate of Case School of Applied Science and has had a number of years of industrial experience in chemical and metallurgical work.

Management Congress Will Meet in Washington

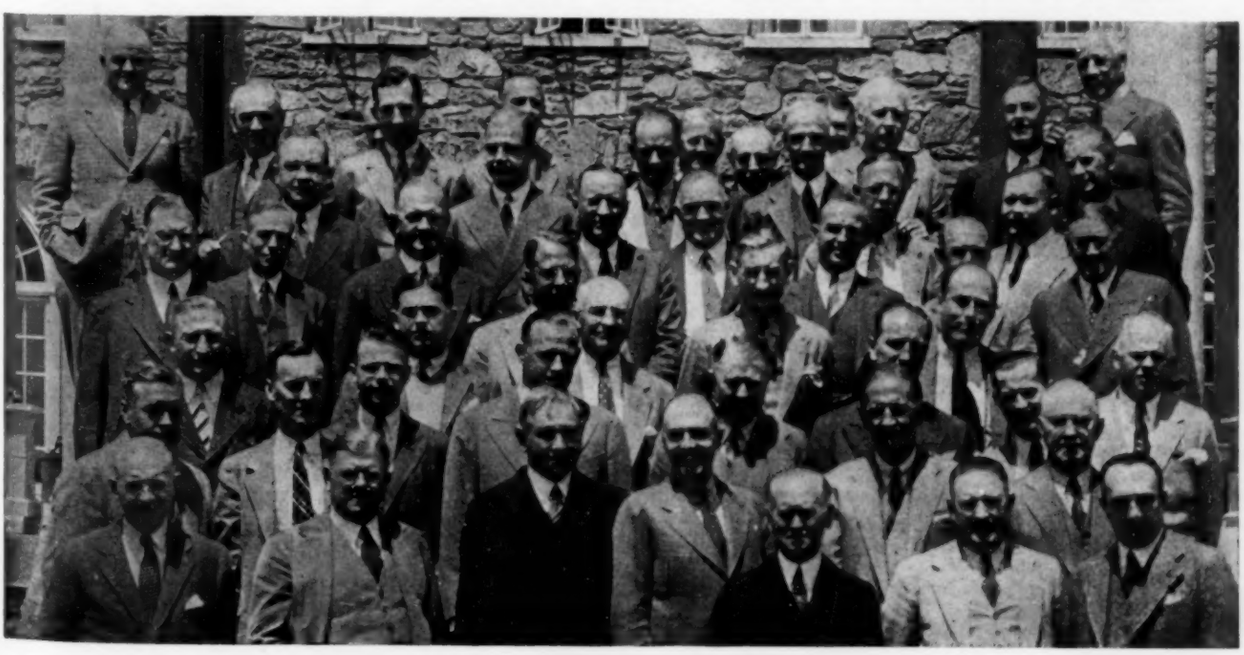
The Seventh International Management Congress, to be held in Washington, September 19 to 23, is expected to attract representatives from approximately forty different countries, who will confer upon management problems for a period of five days.

A Commerce and Industry Committee consisting of prominent industrialists has been formed with Lewis H. Brown, president of Johns-Manville Corp. as chairman.

More than 200 papers in seven volumes will be published and distributed prior to the meeting and will serve as the basis of discussion at six simultaneous technical sessions of the Congress. Sectional meetings will be held for the discussion of problems relating to administration, production, distribution, personnel, agriculture, and the home. At the general sessions, important questions directly relating to the problems of labor, government and business will be presented by outstanding authorities from the countries represented.

The first activities of the Commerce and Industry Committee, Mr. Brown announced, will be to complete plans for financing for which quotas have been set up for 20 industrial groups.

Some of the members of the Manufacturing Chemists' Association in attendance at annual meeting at Skytop Lodge



NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

POLITICS is a dominant factor in every problem which has a Washington angle. Election of New Dealers to the next Congress is so important to the administration that even other aspects of reform and relief are being sacrificed to it. Despite the sharp defeat in Iowa, there is no expectation of a lessening of the pressure in other states. A little greater subtlety may be practiced, but there has been no change of heart or plan.

These facts must be borne in mind in appraising the results which have been achieved by the session of Congress which is approaching adjournment as this news is written. They account for a number of otherwise unexplainable shifts in policy on technical questions, such as food and drug, stream pollution, and other reform legislation. With respect to these and other bills of process-industry importance, there has been the unusual phenomena of support by industries which previously opposed, and the willingness of the administration to allow bills nearing enactment to die. In a number of cases this last change has apparently resulted from the tempering of bills to a practical workable basis after long Congressional study. Such moderate legislation does not satisfy the reformers. They would rather have none at all.

Patent Laws

Despite numerous sincere efforts, Congress has succeeded in passing only one patent bill of importance. This is intended to prevent fraud and other improper practice before the Patent Office. It gives the Commissioner of Patents more definite authority to prevent the unscrupulous activities of those who are, or should be, disbarred from practice for deception of the public.

The Peterson bill which proposed to limit the imports of goods made under process patents did not get beyond House hearings. But a good record was made and it is likely that this measure will be renewed in the next Congress with some chance of attention.

The proposal for compulsory licensing of patents has been abandoned in order that this matter may become a part of the anti-monopoly studies which the President has asked Congress to make. The extreme bills proposed, particularly the McFarlane bill, will probably not be renewed but the general idea of preventing monopolistic use of patents will come up again with strength next year.

Foreign Trade

Many theories are advanced to explain why so little progress is being made on the negotiations with Canadian and British authorities for the new trade agreements. British coolness in part accounts for this, though some in Washington think that any announcement on this subject now before elections would be too dangerous.

Officials in Washington continue to expect the progress of Germany eastward in her effort to round out the supply of needed raw materials. It was no surprise in the Capital that the Czechs were thrown to the German wolves by Italy; but ready English and French concurrence in the eastward progress of the Nazis was not expected, nor welcomed. So long as Germany can work eastward without fighting, this relieves the strain on the French and the danger of general hostilities. Further concessions in this direction are, therefore, to be expected.

Building stock piles of strategic materials as a reserve against military emergencies is being seriously considered. Some progress will be made by the Navy during the next year. The magnitude of this advance will depend on how much money Congress decides to grant for the purpose at the last minute. The idea is that reserves of the major items on the list of 26 strategic materials will be built up by outright purchase to be held in stores under Government ownership and control. Nine minerals, several drugs, coffee, and a number of raw materials for process industry, are included. Of greatest chemical interest are rubber, hides, shellac, camphor, and the cordage fibers.

T.V.A. Inquiry

The first statements before the Congressional committee investigating T.V.A. amounted only to charges by ex-Chairman Morgan and countercharges by the other directors. Almost no new information was given. The staff of the committee will spend several months investigating the situation in the Valley while the ex-chairman searches the records to reinforce his case. By order of the committee he was given access to these records so that he might not lack for any recorded facts in the presentation of his charges. It is expected that hearings will not be renewed until early Fall.

Despite its original decision against building of the Gilbertsville dam, Congress changed its mind and authorized money to start that project during the next fiscal year. It is expected that there will be some protests later regarding the drowning out of mineral deposits (particularly fluorspar) along the lower regions of the Tennessee. But the better-informed people in Washington feel that there will be no important loss of mineral reserves, as some have claimed. There are not likely to be any more Berry marble cases, even if some deposits are drowned.

Continuance of T.V.A. phosphate work along the lines of research and educational activity is expected. There is little probability that the T.V.A. staff will do much in Idaho with respect to phosphates, as that project seems to have become moribund, despite the President's message suggesting a Congressional inquiry.

Price Policy

New Deal reformers are now emphasizing frequently the "disadvantage to the public" of uniform prices for industrial goods. They make little or no distinction between commodities for which price decline stimulates consumption and others for which the consumption is dependent almost wholly on other factors than price. Officials advocating this new economic philosophy are criticizing industry, particularly big business, because the prices of goods are often kept uniform regardless of business conditions. Industrial executives are likely to be confronted with these charges frequently in the future, and they are being warned by their Washington representatives to be prepared to defend uniform-price policies.

Those with any long acquaintance with Washington recall that in previous times official criticism has more commonly been directed against those whose goods fluctuated widely in price. Those who maintained uniform prices during boom and depression periods were formerly complimented, not criticized.

A comprehensive inquiry of statistical and economic nature is planned by the Bureau of Mines, to begin July 1. At that date it is expected that there will be available a small additional appropriation from Congress with which the Economics Branch of the Bureau can undertake a continuing study of scrap metal and the production of secondary metals, both ferrous and non-ferrous. This work will be done by a new unit to be established at the Pittsburgh Laboratory, from which headquarters both field studies and statistical inquiry will be directed.

Conference committee on the stream pollution bill agreed to set up in the Public Health Service a division of water pollution control.

AUSTRIAN CHEMICAL INDUSTRY WILL BE EXPANDED UNDER GERMAN DIRECTION

From Our German Correspondent

ALTHOUGH Austria to some extent suffers from the same raw material deficiencies as Germany, it brings into the "Four Year Plan" economy a small but highly developed chemical industry, a number of valuable resources to supplement those of the Reich, and a strategic position on the Danube which will facilitate German trade expansion to the Southeast.

When the canal connecting the Rhine and the Danube via the Main river is completed in 1945, the Ruhr and Rhine industrial districts will have cheap transportation to the Balkans and the Black Sea. For employment creation purposes, work is being speeded up on this quarter-century old project so that at a cost of 750 million RM the remainder of the canal will be finished in seven instead of twelve years as originally scheduled. A Danube port is to be built at Vienna, and the "Anschluss" has extended German jurisdiction over the Danube by over 200 miles. It also seems probable that Austria's chemical plants will be extended to supply Germany's growing Southeastern markets at closer range, for chemicals and machinery loom large in the Balkan trade which brings agricultural products and petroleum in return.

The development of Austria's chemical industry following the World War is typical of other industries in that country. Far-reaching re-orientation was necessary due to the drastic territorial reduction, the unbalanced ratio of urban to rural population, the loss of seaports, the dismemberment of former markets, and the erection of high tariff barriers by the Successor States. Roughly 80 per cent of the old Empire's industries, and 75 per cent of the chemical plants, were located in the German-populated Sudetic regions awarded to Czechoslovakia. (See *Chem. & Met,* September 1937). The remaining plants were in a difficult position, and since they were no longer producing on a volume basis, could not compete in foreign markets with the large German, Czechoslovak, and Swiss chemical concerns. This disadvantage became worse with the post-depression devaluation of foreign currencies. The Austrian chemical industry has been ailing ever since the War. Its production capacity was utilized only 40 per cent from 1930 to 1933 and 60 per cent in 1936, and even with tariff protection the domestic market in recent years was supplied largely from abroad, with imports greatly exceeding exports. Approximately 33,000 persons are engaged in the chemical industry in the broader sense, but 13,000 of them are unemployed at present.

The structure of Austria's foreign trade in chemicals prior to the "Anschluss" consisted of an extensive list of chemicals imported in relatively small quantities. The largest import items were coal-tar dyes, medicinal preparations, and fertilizers, one-half to two-thirds of which were supplied by Germany alone. Exports comprised resin, turpentine, medicine, glue, calcium carbide, and other items. The United States' exports to Austria were relatively small and included chiefly sulphur, borax, petroleum jelly, carbon black, fertilizers, etc.

The addition of Austria's raw material assets—though not basically altering the Reich's raw material position—will help ease Germany's import necessities as Austria's former exports appear in Reich internal trade. Austria's surplus dairy products will help in relieving the butter and fat shortage, but in general Austria has to import the same foods as Germany. Most important raw material contributed will be timber, which heretofore has comprised one-fifth of Austria's export trade, and which will now make Germany nearly self-sufficient in this item—a factor of importance in view of the new chemical processes constantly requiring more wood as raw material.

Austria's iron ore output should cut down Germany's import requirements by about 10 per cent. Known deposits are estimated at 220 million tons with an iron content of about 80 million tons. At present one-tenth of Austria's ore is mined in East Carynthia and nine-tenths in the province of Styria from the so-called "Steierscher Erzberg." After treatment this ore runs about 45 per cent Fe, 2 per cent Mn, .04 per cent S, and .03 per cent P. The Linz plant will refine these ores, and the government intends to develop other sources.

Austrian oil production, which was almost negligible until recently, will be forced, especially in view of new finds at a 4,500-foot level in the Zistersdorf area, which will double production this year. Boring equipment for new development is to be supplied by the Reich, but this additional oil will by no means help Germany solve her oil problems. The deficit of fuels has been partly made up, however, by abundant water power developed in the mountainous regions, and in the past an export surplus of 10 to 15 per cent has been sold, mostly to Germany. This abundance of power and a plentiful supply of salt have made electrolytic soda and chlorine production possible.

Graphite, magnesite, and talc are other minerals in which Austria produces exportable surpluses. Deposits of magnesite extend through Austria's mountains from North Styria to the Tyrol. Austria enjoys a semi-monopoly of this useful material and produces twice as much as the United States, her only rival in the field. Limestone also abounds for the production of calcium carbide, heretofore one of Austria's chief chemical export items.

Among new developments in the Austrian chemical industry, the Reich has announced the construction of new cellulose factories. A large plant at St. Pölten which has been producing rayon for some time is now adding staple fiber to its program. In Vienna-Neustadt a "cell wool" plant using German processes is projected; with the abundance of milk, the Italian Snia Viscosa casein fiber will also be produced. At Reichraming a pilot plant is producing sugar and byproducts from wood. The Lenzinger paper factory has recently completed plant extensions, and production capacities of Leykam-Josefstal A.G. plants in Gratwein (Styria) and of Bunzl & Bach in Wattens are also being increased. At Linz the "Teerag" company has opened a new plant producing resin, tar, asphalt roofing, and insulating materials.

Coal tar dyes are not produced in large quantities in Austria, about 70 per cent of domestic consumption having been imported from the Reich. However, the new Pilz & Heinzeneder plant at Salzburg has recently undertaken the production of dyes and cosmetics. Synthetic nitrogenous products have also been relatively weak, although the German I.G. Farben and Dynamite Nobel as well as the Swiss Hydronitro S.A. groups have projected large plants to manufacture them. The plant of the liquidating Mitterberge Kupfer A.G. was recently purchased by a chemical group for the manufacture of nitrogenous products. Austria's yearly production has averaged 40,000 tons of superphosophates, 7,000 tons of ammonium sulphate, and 5,000 tons of phosphoric precipitates. The Skoda-Werke Wetzler A.G. has just completed a new phosphoric acid plant at Moosierbaum.

Germany is acquiring the two large factories of the Semperit concern in Winnpassing and Traiskirchen in Lower Austria, which produce much of Austria's rubber. Austria also has a well-developed paint, lacquer and varnish industry, specializing in ultramarine, bronze and lead colors, and lithophone. In this field, the Bablick Bros. have opened a new plant at Brunn-am-Gebirge for manufacture of zinc white.

PERSONALITIES

✦ R. L. BALDWIN, of the National Carbon Co., Niagara Falls, was elected president of the Electrochemical Society at its recent annual meeting at Savannah, Ga.

✦ CHRIS F. BINGHAM is in charge of Columbia Alkali Corp.'s new Philadelphia sales office, opened this month. Mr. Bingham was formerly in Columbia's technical service department.

✦ MARSTON T. BOGERT, professor of organic chemistry at Columbia University, has been awarded the Priestly gold medal of the American Chemical Society.

✦ K. R. BURKE, general superintendent of Koppers Company's tar and chemical division has been elected a vice-president of that company.

✦ WALLACE P. COHOE, consulting chemical engineer, New York City, has been elected chairman of the American Section of the Society of Chemical Industry for the year 1938-39. Lincoln T. Work, professor of chemical engineering at Columbia University, has been elected vice-chairman.

✦ ALLAN P. COLBURN has been appointed head of the division of chemical engineering at the University of Delaware. Dr. Colburn leaves the experiment station of E. I. duPont de Nemours & Co., where he was engaged in chemical engineering research. One of his first duties at Delaware will be the introduction of a five-year curriculum in chemical engineering.

✦ FREDERICK G. COTTRELL, well-known inventor of the Cottrell electrostatic separator, was awarded the medal of the American Institute of Chemists in recognition of his service to the chemical profession.

✦ VINCENT A. CURLL, formerly in production work at the General Chemical Co., has joined the Pennsylvania Salt Mfg. Co. as technical salesman, specializing in acid-proof cements.

✦ R. G. DUNNING, formerly of the Barber Asphalt Co., has taken a position in the pilot plant department of Merck & Co. at Rahway, N. J.

✦ ROBERT EGBERT, senior in chemical engineering at Cooper Union, was 1938 winner of the A. McLaren White Award for the best solution submitted in the undergraduate student problem contest sponsored annually by the American Institute of Chemical Engineers. This is the third successive year that the first prize has been won by a Cooper Union student.

Allan P. Colburn

Warren L. McCabe

✦ EMERSON FRANTZ has been appointed general sales manager of the Bohn Aluminum & Brass Corp., Detroit, Mich., where since 1933 he has been in charge of production and engineering of the bearings division.

✦ PAUL W. FRISK, manager of the chemical laboratory of the American Enka Corp., Enka., N. C., has been elected president of the newly formed Engineers' Club of Western North Carolina.

✦ HOWARD FRITZ has been made mechanical rubber merchandising manager of the B. F. Goodrich Co., Akron, Ohio. Dr. Fritz was formerly in charge of the sale and development of Koroseal.

✦ ROBERT C. GUNNESS, former director of the Parlin field station of the School of Chemical Engineering Practice of Massachusetts Institute of Technology, has accepted a position with the Standard Oil Co. of Indiana at Whiting, Ind.; JOHN E. EBERHARDT, formerly director of the Buffalo station, has joined the Bethlehem Steel Co. at Bethlehem, Pa.; and HOWARD F. GARDNER, formerly director of the Bangor station, is to be assistant professor and in charge of chemical engineering at the University of Rochester. The new directors of the field stations are JAMES E. SEEBOLD at Parlin, GEORGE A. AKIN at Buffalo, and ROY P. WHITNEY at Bangor.

✦ MILTON P. HIGGINS has been appointed resident manager of the Chippewa, Ont. electric furnace plant of the Norton Co.

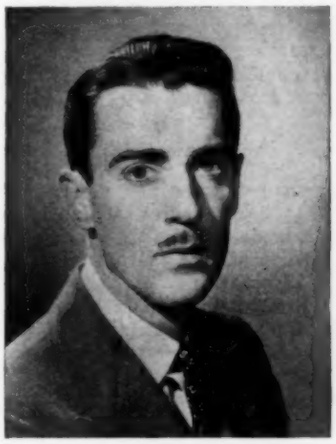
✦ JOHN KLEMPNER, secretary-treasurer of Curtin-Howe Corp., a subsidiary of United Chemicals, Inc., has written in his spare time a best-selling novel entitled "No Stork at Nine". Published recently by Scribner's, the book has been received enthusiastically by critics and is about to go into its third printing.

✦ ELMER O. KRAEMER is resigning from E. I. duPont de Nemours & Co. to accept a special award of $2,500 from the Lalor Foundation with which to continue his studies of giant molecules such as starch, cellulose and rubber. Dr. Kraemer will carry out his investigations in the laboratory of Professor The Svedberg at the University of Upsala in Sweden.

✦ E. C. LATHROP has resigned as technical director of the Crown Zellerbach Corp. to become vice-president of the Celotex Corp., Chicago. Dr. Lathrop was director of research and development for the Celotex Corp. for a number of years.

✦ FREDERICK MARSIGLIO has resigned as director of research of the J. P. Baker Chemical Co., Phillipsburg, N. J.

✦ WARREN L. MCCABE, head of the department of chemical engineering at Carnegie Institute of Technology, is the recipient of the third William H. Walker Award. Made annually by the American Institute of Chemical Engineers, the award is in recognition of outstanding contributions to chemical engineering literature.



E. Scott Pattison

Chris F. Bingham

Vincent A. Curll

✦ R. J. MOORE, development manager of the varnish-resin division of the Bakelite Corporation, has been elected president of the American Institute of Chemists to succeed Dr. Maximilian Toch.

✦ E. SCOTT PATTISON, former assistant advertising manager of the Mathieson Alkali Works and now publicity manager for the G. M. Basford Co., New York City, has been named one of the five young industrial executives to receive a year's study in business administration and economics at Massachusetts Institute of Technology under a fellowship grant of the Alfred P. Sloan Foundation. Mr. Pattison received his chemical engineering degree from Rensselaer Polytechnic Institute in 1929.

✦ BERAM D. SAKLATWALLA, whose accomplishments in the development of chromium-copper steels are familiar to metallurgists, has with Frederick D. Foote formed the Alloys Development Corp. of New York as successor to U. S. Rustless Steel & Iron Corp. Mr. Foote has been elected president of the new corporation.

✦ GERALD L. SIMARD has become a research associate at Battelle Memorial Institute, Columbus, Ohio, where he will investigate the use of electron diffraction methods in the study of oil films. The project is sponsored jointly by the Institute and by the Atlantic Refining Co.

✦ FRANKLIN ELLIOTT TUTTLE, revered teacher of chemistry to two generations of University of Kentucky students and former head of the chemistry department at that institution, received a tribute this month from his former pupils in the form of a bronze portrait placque presented to the University in his honor.

✦ ROBERT YORK, JR. will join the faculty of Carnegie Institute of Technology this fall as instructor in chemical engineering. He will receive his doctor of science degree from the University of Tennessee this June.

✦ O. T. ZIMMERMAN, who has been teaching chemical engineering at the University of North Dakota since receiving his degree from the University of Michigan in 1934, has been appointed associate professor of chemical engineering at the University of New Hampshire. Dr. Zimmerman will initiate and develop a chemical engineering option as part of the chemistry curriculum now offered at New Hampshire.

CALENDAR

SOCIETY OF CHEMICAL INDUSTRY, annual meeting of all sections, Ottawa, Canada, June 20–22.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, N. J., June 27–July 1.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting, Milwaukee, Wis., Sept. 5–9.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, semi-annual meeting, Green Bay, Wis., Sept. 8–10.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, semi-annual meeting, Philadelphia, Pa., Nov. 9–11.

THIRTEENTH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING, Grand Central Palace, New York City, Dec. 5–10.

AMERICAN CERAMIC SOCIETY, Hotel Stevens, Chicago, Ill., April 16–21, 1939.

OBITUARY

✦ JOHN NORVIN COMPTON, chief chemical engineer of Carbide and Carbon Chemicals Corp. and author of article on pages 306–9 of this issued, died in Charleston, W. Va., June 14 at the age of 44.

✦ ELMER P. KOHLER, Sheldon Emory professor of organic chemistry and head of the department of chemistry at Harvard University, died May 24 in Boston at the age of 72.

✦ JOSEPH W. MELLOR, noted English chemist, died in London on May 24. Dr. Mellor completed the final volume of his famous "Treatise on Inorganic and Theoretical Chemistry" last year.

✦ HERBERT L. MERRICK, founder and president of the Merrick Scale Manufacturing Co., died May 10 at his home in Passaic, N. J.

✦ MAX MUELLER, prominent manufacturing chemist and president and treasurer of the Technical Equipment Corporation, New York City, died April 15, at Newark, N. J. at the age of 62.

✦ CARL G. SCHLEUDERBERG, vice-president and general manager of the Ford Instrument Co., a subsidiary of the Sperry Corp., died April 9, at age of 57.

CHEMICAL-CONSUMING INDUSTRIES FAIL TO IMPROVE POSITION

THE index for industrial production declined to 77 in April according to the findings of the Federal Reserve Board. This marks a downward course and as the figure for May is expected to show a slight drop from the April level, it is evident that general business has not changed its course materially in the last three or four months. The accompanying tabulation, showing the status of some of the principal chemical-consuming industries, makes it correspondingly evident that the chemical industry has followed the tenor of general business. Consumption of chemicals recorded a fair gain in March but failed to hold that rate of operation and the industry as a whole has moved along a horizontal line or declined somewhat in the intervening months.

Data for the respective chemical-consuming industries for the first four months of the year explain the degree of decline and point out in what directions the drop in consumption has been most severe. The textile industry, for instance, compared with the first four months of last year, reports declines in consumption of 37 per cent for cotton, 20.2 per cent for silk, and 63 per cent for wool. Automotive production, down more than 65 per cent, has contributed to the slower call for rubber and to the sharp drop in the output of plate glass.

Byproduct coke production has fallen off in almost direct proportion to the lessening in steel activities and crude coal-tar products follow closely the trend in byproduct coke production. Synthetic methanol still holds to new production records but the rate of activities has been lowered and it is probable that production has been somewhat ahead of consumption.

Manufacturers' sales during April 1938 declined 29 per cent from last April according to reports from about 1,000 manufacturers cooperating in the monthly joint study of the National Association of Credit Men and the Bureau of Foreign and Domestic Commerce. This decrease equaled the 29 per cent decline recorded in January from last year, and exceeded the declines of 22 and 23 per cent registered in February and March respectively.

Total net sales of manufacturers during April decreased 9 per cent from March 1938 without adjustment for seasonal variation. This compares with a decrease of 2 per cent from March to April in 1937.

Every major industry group for which sales data are shown, except the printing, publishing, and allied industries group, whose sales increased 9½ per cent, registered a decrease in sales during April 1938 from April of last year. The smallest decline was registered by the petroleum products industry, whose sales were down 4 per cent on this comparison. Other decreases ranged down to the drop of 58 per cent recorded by the iron and steel products group.

The chemical and allied products group reported an increase of 1.4 per cent for April sales as compared with March but were 21 per cent below the total for March 1937. Sales of paint and varnish showed a gain of 9.6 per cent over March and a decline of 23.3 per cent from April 1937.

Superphosphate production in April, for the fourth consecutive month, was well under the corresponding month of last year. The seasonal decline from March was somewhat less than usual. According to reports by acidulators to The National Fertilizer Association, April production was 27 per cent below April 1937, but 23 per cent larger than in April 1936. A substantial decline from last year was reported in the southern area.

Production and Consumption Data for Chemical-Consuming Industries

	April 1938	April 1937	Jan.-April 1938	Jan.-April 1937	Per cent of decline for 1938
PRODUCTION					
Automobiles, No.	219,314	536,150	838,191	1,774,067	52.7
Alcohol, ethyl, 1000 pr. gal.	12,739	16,824	63,600	72,974	12.8
Alcohol denatured, 1000 wi. gal.	6,287	7,099	23,464	25,933	9.5
Byproduct coke, 1000 tons	2,436	4,349	10,367	17,193	39.7
Glass containers, 1000 gr.	3,647	4,543	13,404	16,660	24.3
Plate glass, 1000 sq. ft.	3,820	21,956	15,405	67,748	77.3
Methanol, crude, gal.	314,664	531,727	1,614,741	2,104,144	23.3
Methanol, synthetic, gal.	1,975,999	2,138,895	9,507,330	7,895,759	16.9*
Rosin, wood, bbl.	50,597	61,742	192,088	241,377	20.4
Turpentine, wood, bbl.	8,007	9,840	29,692	38,373	22.6
Rubber reclaimed, tons	6,399	13,884	26,547	58,667	54.7
Sulphuric acid in fertilizer industry, tons	143,469	180,040	641,301	729,490	12.1
CONSUMPTION					
Cotton, 1000 bales	414	719	1,788	2,840	37.0
Silk, bales	33,381	40,561	129,240	163,177	20.2
Wool, 1000 lb.	15,952	41,983	63,145	170 974	63.1
Explosives, 1000 lb.	22,961	41,870	98,747	140,874	29.9
Paint, varnish and lacquer, $1000	34,732	46,345	110,202	148,148	25.5
Sulphuric acid in fertilizers, tons	110,496	172,936	512,466	698,270	26.6

* Per cent of increase.

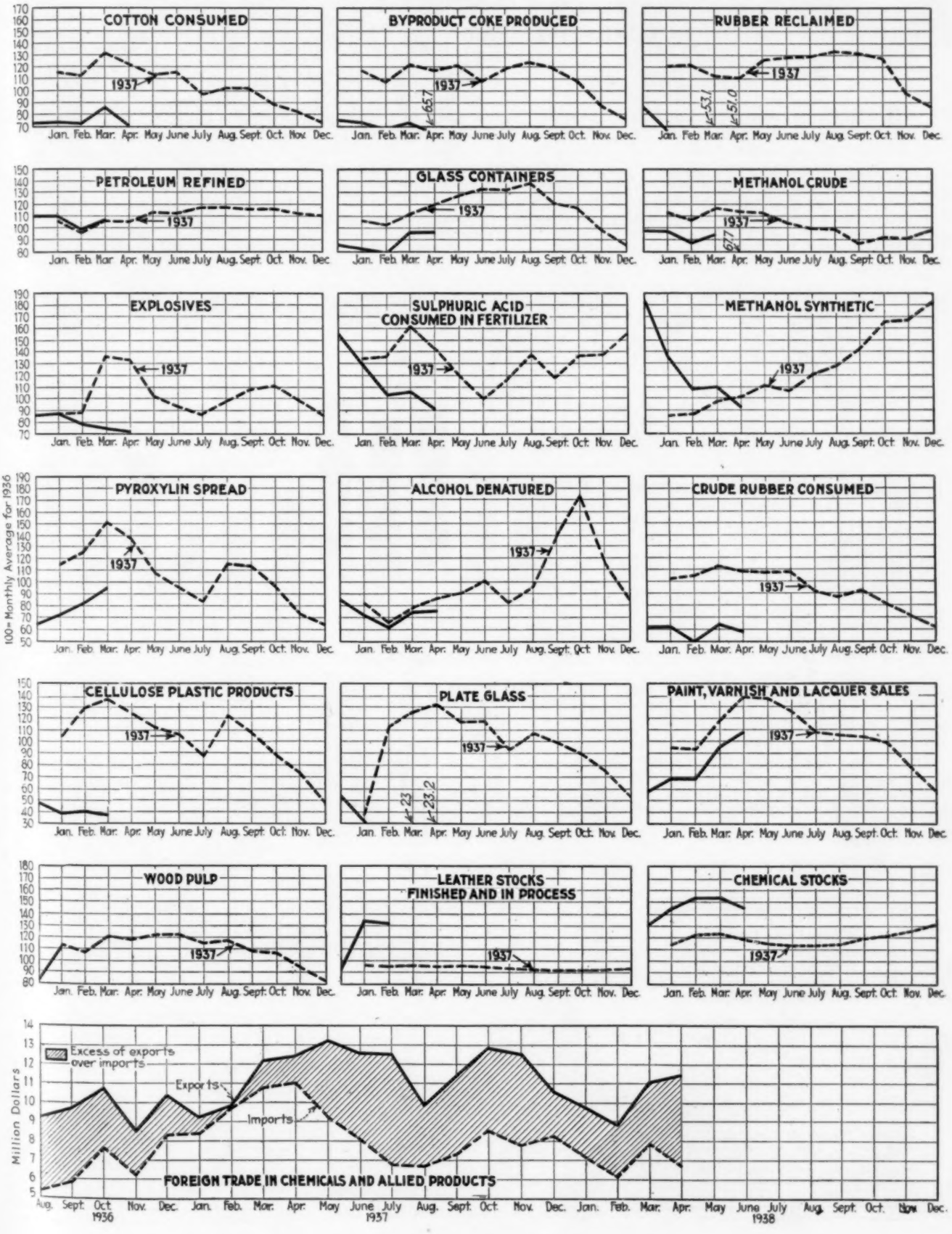
Production of Acetic Acid and Derivatives in 1937

In terms of 100 per cent acetic acid

	Primary production (thousands of pounds)							Percentage of total		
	From calcium acetate [1]			By other methods						
Year	Domestic [2]	Imported [2]	Total	Direct recovery	Synthesis and fermentation [4]	Total	Total	Made by from calcium acetate	Made by direct recovery methods	Made by synthesis and fermentation [4]
1927	82,966	3,939	86,905	[5]	[5]	12,523	99,428	87.4	[5]	[5]
1928	87,217	5,146	92,363	6,934	13,045	19,979	112,342	82.2	6.2	11.6
1929	71,273	14,078	85,321	9,268	33,880	43,148	128,469	66.4	7.2	26.4
1930	37,292	7,920	45,212	8,312	36,265	44,577	89,789	50.3	9.3	40.4
1931	33,482	None	33,482	8,963	37,206	46,169	79,651	42.0	11.3	46.7
1932	22,940	None	22,940	[6] 7,479	35,841	43,320	66,260	34.6	11.3	54.1
1933	25,294	150	25,444	9,958	54,211	64,169	89,613	28.4	11.1	60.5
1934	26,983	118	27,101	11,935	73,266	85,201	112,302	24.1	10.6	65.3
1935	42,654	None	42,654	13,537	102,994	116,531	159,185	26.8	8.5	64.7
1936	35,780	None	35,780	17,577	122,316	139,893	175,673	20.4	10.0	69.6
1937	20,592	None	20,592	18,047	138,550	156,597	177,189	11.6	10.2	78.2

[1] Converted on the basis of 1 pound of 100 percent acetic acid to 1.75 pounds of 80 percent calcium acetate.
[2] 1927–33 based upon monthly reports of the Bureau of the Census: 1934–37 furnished by the Wood Chemical Institute. Adjusted for stocks on hand at beginning and end of year, and for exports.
[3] Assuming conversion to acid during year of importation.
[4] Including derivatives made directly without intermediate recovery of acetic acid.
[5] Not publishable.
[6] Partially estimated by U. S. Tariff Commission.
Note: Certain figures in this table differ from those given in the Commission's press release of May 1934 due to later revisions.

PRODUCTION AND CONSUMPTION TRENDS



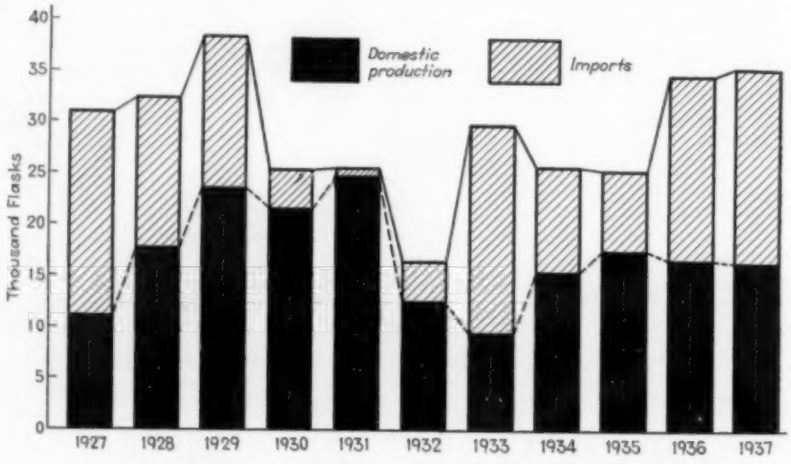
CHEMICAL PRICES REFLECT CONTINUED SLOW BUYING MOVEMENT

WITH large consuming industries holding to restricted production schedules, the market for chemicals, and in fact for most raw materials, is lacking in developments. The price tone is easy and the weighted index number for the month was lower than a month ago. The outlook favors a continuance of quiet conditions for the next two months with government spending expected to have a favorable effect from September forward.

During the last month while commodity prices in general were on a downward trend, a striking exception was found in the case of mercury. Shortly after the middle of May prices for shipment from abroad were advanced to a basis of $64 a flask c.i.f. New York and this was followed by a later marking up of another dollar per flask. Adding duty of $19 per flask, established a landed cost of $84 per flask for the foreign material which represented a rise of $15 a flank over the price previously in effect.

The advance in price was so sharp that it attracted wide attention and speculation regarding the underlying causes has covered a wide range of probabilities with no authoritative explanation offered.

According to a survey made by the U.S. Bureau of Mines, domestic production of mercury in 1937 was about the same as in 1936. The output for 1937 was reported at 16,508 flasks as compared with 16,569 flasks produced in the preceding year. Production activities last year, however, were far from evenly distributed and the Bureau points out that the apparently steady output failed to show the violent fluctuations in rates of operation at individual mines. Early in the year when demand and prices were high, active mines were working at capacity and new mines were preparing to enter production. Late in the year buying interest was lacking and sales prices declined with the result that most mines were closed and those in operation were worked at only a small fraction of their capacities.



Domestic Production and Imports of Mercury.

Mercury Production and Imports

	Domestic Production Flasks	Imports Flasks	Total Supply Flasks
1937	16,508	18,917	35,425
1936	16,569	18,088	34,657
1935	17,518	7,815	25,333
1934	15,445	10,192	25,637
1933	9,669	20,315	29,984
1932	12,622	3,886	16,508
1931	24,947	549	25,496
1930	21,553	3,725	25,278
1929	23,682	14,917	38,599
1928	17,870	14,562	32,432
1927	11,128	19,941	31,069

Average Prices for Mercury at New York

	Flask		Flask
1937	$90.18	1931	$87.35
1936	79.92	1930	115.01
1935	71.99	1929	122.15
1934	73.87	1928	123.51
1933	59.23	1927	118.16
1932	57.93	1926	93.13

Deliveries of potash for agricultural purposes within the continental United States, Canada, Cuba, Puerto Rico, and Hawaii for the first quarter of this year according to the American Potash Institute amounted to 78,756 tons of actual K_2O as against 131,388 tons a year ago. The total shipped in the first quarter of this year was the equivalent of 161,799 tons of potash salt compared with 266,354 tons for the first quarter of last year, the figures referring to deliveries and not to consumption.

According to a report from the Bureau of Mines, domestic production of carbon black last year reached an all-time high of 510,606,000 lb. Consumption failed to keep pace with production, however, and as a result there was an accumulation of stocks at producing points, amounting to 100,497,000 lb. by the end of the year. The slow position of the rubber trade in the latter part of last year and through the present year to date has cut down sharply the volume of carbon black consumed domestically and has kept prices at a low level. Export buying has made a more favorable showing and it is now announced that the higher price which has existed for export sales will be continued. Exports last year amounted to 184,030,000 lb. with the United Kingdom, France, and Germany taking 105,594,000 lb.

Countervailing duties no longer will be applied to iron oxide and plastic bricks from Canada, strychnine from Switzerland, butyl acetate from Germany and stearic acid from Holland, the Treasury announces. Reports to the Treasury indicate that efforts to dump this type of goods have been discontinued.

CHEM. & MET. Weighted Index of CHEMICAL PRICES

Base = 100 for 1935

This month	**99.79**
Last month	100.32
June, 1937	101.80
June, 1936	98.58

Some of the solvents, lead oxides, acetate of lead, aluminum sulphate, and turpentine were among the commodities for which lower prices went into effect. The long-continued era of restricted buying has taken the edge off most products without any general price decline.

CHEM. & MET. Weighted Index of Prices for OILS AND FATS

Base = 100 for 1935

This month	**74.98**
Last month	80.25
June, 1937	109.34
June, 1936	102.53

Weakness was general throughout the market for oils and fats. Consuming demand remains quiet and prices are influenced by the lack of buying interest. Oils of foreign origin followed the general price trend.

Current PRICES

INDUSTRIAL CHEMICALS

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.05½–$0.06½	$0.05½–$0.06½	$0.06 –$0.07
Acid, acetic, 28%, bbl., cwt.	2.23 – 2.48	2.23 – 2.48	2.53 – 2.78
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.70 – 8.95
U. S. P. reagent	10.25 –10.50	10.25 –10.50	10.75 –11.00
Boric, bbl., ton	105.00–115.00	105.00–115.00	105.00–115.00
Citric, kegs, lb.	.24 – .27	.24 – .27	.25 – .28
Formic, bbl., ton	.10½– .11	.10½– .11	.11 – .11½
Gallic, tech., bbl., lb.	.75 – .78	.75 – .78	.60 – .65
Hydrofluoric 30% carb., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb.	.06½– .06½	.06½– .06½	.6½ – .6½
Muriatic, 18°, tanks, cwt.	1.05 –.....	1.05 –.....	1.00 – 1.10
Nitric, 36°, carboys, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –.....	18.50 –20.00
Oxalic, crystals, bbl., lb.	.10½– .12	.10½– .12	.10½– .12
Phosphoric, tech., c'boys., lb.	.09 – .10	.09 – .10	.09 – .10
Sulphuric, 60°, tanks, ton	13.00 –.....	13.00 –.....	11.00 –11.50
Sulphuric, 66°, tanks, ton	16.50 –.....	16.50 –.....	15.50 –.....
Tannic, tech., bbl., lb.	.40 – .45	.40 – .45	.26 – .30
Tartaric, powd., bbl., lb.	.26½– .26½	.25½– .26	.23½– .24½
Tungstic, bbl., lb.	2.75 –.....	2.75 –.....	2.50 – 2.75
Alcohol, Amyl	.....	.....	.....
From Pentane, tanks, lb.	.12⅓–.....	.12⅓–.....	.12⅓–.....
Alcohol, Butyl, tanks, lb.	.08½–.....	.08½–.....	.08½–.....
Alcohol, Ethyl, 190p'f., bbl., gal.	4.11 –.....	4.11 –.....	4.14 –.....
Denatured, 190 proof			
No. 1 special, dr., gal wks.	.31 –.....	.31 –.....	.32 –.....
Alum, ammonia, lump, bbl., lb.	.03½– .04	.03½– .04	.03 – .04
Potash, lump, bbl., lb.	.03½– .04	.03½– .04	.03 – .04
Aluminum sulphate, com bags cwt.	1.15 – 1.40	1.35 – 1.50	1.35 – 1.50
Iron free, bg., cwt.	1.30 – 1.55	2.00 – 2.25	2.00 – 2.25
Aqua ammonia, 26°, drums, lb.	.02½– .03	.02½– .03	.02½– .03
tanks, lb.	.02½– .02½	.02½– .02½	.02½– .02½
Ammonia, anhydrous, cyl., lb.	.15½–.....	.15½–.....	.15½– .16
tanks, lb.	.04½–.....	.04½–.....	.04½–.....
Ammonium carbonate, powd tech., casks, lb.	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks., cwt.	1.475–.....	1.475–.....	1.475–.....
Amylacetate tech., tanks, lb.	.11 – .12	.11 – .12	.11 – .11½
Antimony Oxide, bbl., lb.	.12 – .13	.12½– .13	.16 – .16½
Arsenic, white, powd., bbl., lb.	.03 – .03½	.03 – .03½	.03 – .03½
Red, powd., kegs, lb.	.15½– .16	.15½– .16	.15½– .16
Barium carbonate, bbl., ton	52.50 –57.50	52.50 –57.50	56.50 –58.00
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	72.00 –74.00
Nitrate, cask, lb.	.07 – .08	.07 – .08	.08½– .09
Blanc fixe, dry, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f. o b., wks., drums, cwt.	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Borax, gran., bags, ton	46.00 –51.00	46.00 –51.00	46.00 –51.00
Bromine, cs., lb.	.30 – .32	.30 – .32	.36 – .38
Calcium acetate, bags	1.65 –.....	1.65 –.....	2.25 –.....
Arsenate, dr., lb.	.06½– .07	.06½– .07	.06½– .07
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	21.50 –24.50	21.50 –24.50	20.00 –33.00
flake, dr., del., ton	23.00 –25.00	23.00 –25.00	22.00 –35.00
Phosphate, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb.	.05 – .06	.05 – .06	.05½– .06
Tetrachloride drums, lb.	.05½– .06	.05½– .06	.05½– .06
Chlorine, liquid, tanks, wks., lb.	2.15 –.....	2.15 –.....	2.15 –.....
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb.	1.67 – 1.70	1.67 – 1.70	1.41 – 1.51
Copperas, bgs., f.o.b., wks., ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Copper carbonate, bbl., lb.	.09 – .16½	.09 – .16½	.11½– .16
Sulphate, bbl., cwt.	4.00 – 4.25	4.25 – 4.50	5.15 – 5.40
Cream of tartar, bbl., lb.	.21½– .22	.20½– .21	.17½– .18
Diethylene glycol, dr., lb.	.22 – .23	.22 – .23	.16½– .20½
Epsom salt, dom., tech., bbl., cwt.	1.80 – 2.00	1.80 – 2.00	1.80– 2.00
Ethyl acetate, drums, lb.	.06½–.....	.06½–.....	.07 –.....
Formaldehyde, 40%, bbl., lb.	.05½– .06½	.05½– .06½	.05½– .6½
Furfural, dr., lb.	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, ref. drums, lb.	.16 – .18	.16 – .18	.16 – .18
Glaubers salt, bags, cwt.	.95 – 1.00	.95 – 1.00	.85 – 1.00
Glycerine, c.p., drums, extra, lb.	.15½–.....	.15½–.....	.23½–.....
Lead:			
White, basic carbonate, dry casks, lb.	.06½–.....	.06½–.....	.07½–.....
White, basic sulphate, sck., lb.	.05½–.....	.05½–.....	.07½–.....
Red, dry, sck, lb.	.06½–.....	.07 –.....	.08½–.....
Lead acetate, white crys., bbl., lb.	.10 – .11	.11 – .12	.13½– .14
Lead arsenate, powd., bbl., lb.	.12½– .13	.13 – .13½	.11½– .12
Lime, chem., bulk, ton	8.50 –.....	8.50 –.....	8.50 –.....
Litharge, pwd., csk., lb.	.05½–.....	.06 –.....	.07½–.....
Lithophone, bags, lb.	.04½– .04½	.04½– .04½	.04½– .05
Magnesium carb., tech., bags, lb.	.06 – .06½	.06 – .06½	.06 – .06½

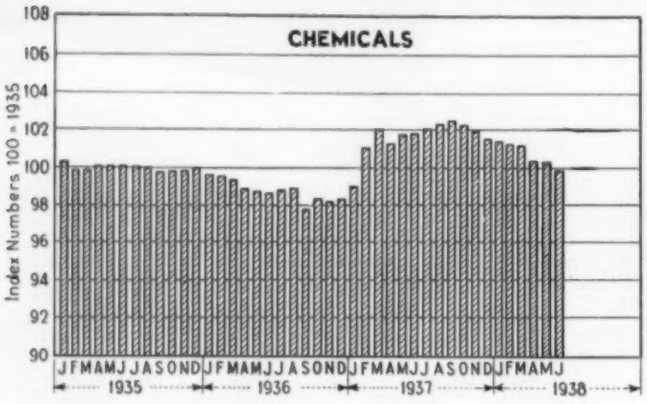
	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal.	.31 –.....	.31 –.....	.33 –.....
97%, tanks, gal.	.32 –.....	.32 –.....	.34 –.....
Synthetic, tanks, gal.	.33 –.....	.33 –.....	.33 –.....
Nickel salt, double, bbl., lb.	.13 – .13½	.13 – .13½	.13 – .13½
Orange mineral, csk., lb.	.09½–.....	.10 –.....	.11½–.....
Phosphorus, red, cases, lb.	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb.	.24 – .30	.24 – .30	.24 – .30
Potassium bichromate, casks, lb.	.08½– .09	.08½– .09	.08½– .09
Carbonate, 80–85%, calc. csk., lb.	.05½– .06	.06½–.....	.07 – .07½
Chlorate, powd., lb.	.09½–.....	.09½– .09	.08½– .09
Hydroxide (c'stic potash) dr., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Muriate, 80% bgs., unit	.53½–.....	.53½–.....	.53½–.....
Nitrate, bbl. lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb.	.15 – .16	.15 – .16	.15 – .16
Sal ammoniac, white, casks, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Salsoda, bbl., cwt.	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt.	1.23 –.....	1.23 –.....	1.23 –.....
Dense, bags, cwt.	1.25 –.....	1.25 –.....	1.25 –.....
Soda, caustic, 76%, solid, drums, contract, cwt.	2.60 – 3.00	2.60 – 3.00	2.60 – 3.00
Acetate, works, bbl., lb.	.04 – .05	.04 – .05	.04½– .05
Bicarbonate, bbl., cwt.	1.75 – 2.00	1.75 – 2.00	1.75 – 2.00
Bichromate, casks, lb.	.06½– .07	.06½– .07	.06½– .07
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Bisulphite, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Chlorate, kegs, lb.	.06½– .06½	.06½– .06½	.06½– .06½
Chloride, tech., ton	12.00 –14.75	12.00 –14.75	12.00 –14.75
Cyanide, cases, dom., lb.	.14 – .15	.14 – .15	.16½– .17
Fluoride, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., cwt.	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt.	2.20 – 3.20	2.20 – 3.20	2.15 – 3.15
Nitrate, bags, cwt.	1.45 –.....	1.45 –.....	1.375–.....
Nitrite, casks, lb.	.06½– .07	.07 – .08	.07½– .08
Phosphate, dibasic, bags, lb.	1.85 –.....	1.85 –.....	.02½– .024
Prussiate, yel. drums, lb.	.09½– .10	.10– .11	.10 – .11
Silicate (40° dr.) wks., cwt.	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, cyra., bbl., lb.	.02½– .02½	.02½– .02½	.02½– .02½
Sulphur, crude at mine, bulk, ton	18.00 –.....	18.00 –.....	18.00– .....
Chloride, dr., lb.	.03 – .04	.03 – .04	.03½– .04
Dioxide, cyl., lb.	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt.	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb.	.44 –.....	.46 –.....	.58 –.....
Crystals, bbl., lb.	.33 –.....	.32½–.....	.40 –.....
Zinc, chloride, gran., bbl., lb.	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb.	.14 – .15	.14 – .15	.09 – .11
Cyanide, dr., lb.	.33 – .35	.36 – .38	.36 – .38
Dust, bbl., lb.	.06½–.....	.06½–.....	.08½–.....
Zinc oxide, lead free, bag., lb.	.06½–.....	.06½–.....	.06 –.....
5% lead sulphate, bags, lb.	.06½–.....	.06½–.....	.05½–.....
Sulphate, bbl., cwt.	3.15 – 3.60	3.15 – 3.60	3.15 – 3.60

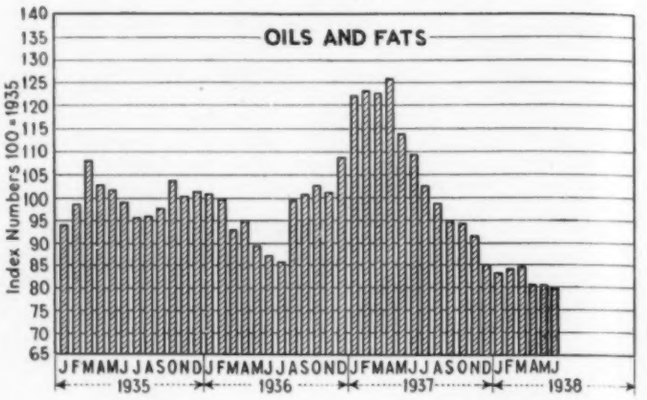
OILS AND FATS

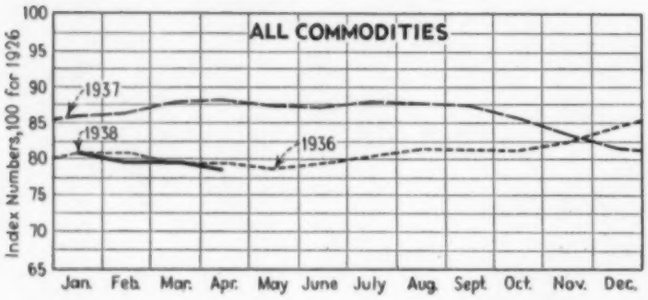
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.09½–$0.10	$0.09½–$0.10	$0.10½–$0.11
Chinawood oil, bbl., lb.	.10½–.....	.12 –.....	.13 –.....
Coconut oil, Ceylon, tanks, N. Y. lb.	.03½–.....	.03½–.....	.06½–.....
Corn oil crude, tanks (f.o.b. mill), lb.	.07 –.....	.07½–.....	.08½–.....
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.06½–.....	.07 –.....	.08½–.....
Linseed oil, raw car lots, bbl., lb.	.086–.....	.093–.....	.11½–.....
Palm, casks, lb.	.03½–.....	.036–.....	.06 –.....
Peanut oil, crude, tanks (mill), lb.	.06½–.....	.07½–.....	.09½–.....
Rapeseed oil, refined, bbl., gal.	.78 –.....	.85 –.....	.93 –.....
Soya bean, tank, lb.	.05½–.....	.05½–.....	.10 –.....
Sulphur (olive foots), bbl., lb.	.07½–.....	.08½–.....	.12 –.....
Cod, Newfoundland, bbl., gal.	.50 –.....	.52 –.....	.52 –.....
Menhaden, light pressed, bbl., lb.	.07½–.....	.081–.....	.11 –.....
Crude, tanks (f.o.b. factory), gal.	.35 –.....	.35 –.....	.45 –.....
Grease, yellow, loose, lb.	.04½–.....	.04½–.....	.08½–.....
Oleo stearine, lb.	.07½–.....	.07½–.....	.09½–.....
Oleo oil, No. 1	.08½–.....	.08½–.....	.13½–.....
Red oil, distilled, d.p. bbl., lb.	.08½–.....	.09½–.....	.10½–.....
Tallow extra, loose, lb.	.04½–.....	.05½–.....	.08½–.....

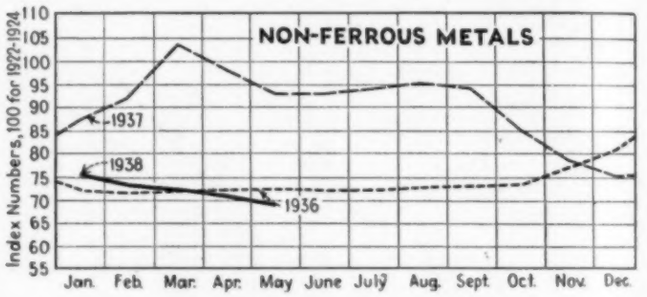
The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to June 13

CHEM. & MET.'S WEIGHTED PRICE INDEXES









COAL-TAR PRODUCTS

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb.	$0.52 -$0.55	$0.52 -$0.55	$0.52 -$0.55
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.15 - .16	.15 - .16	.15 - .16
Aniline salts, bbl., lb.	.22 - .24	.22 - .24	.24 - .25
Benzaldehyde, U.S.P., dr., lb.	.85 - .95	.85 - .95	1.10 - 1.25
Benzidine base, bbl., lb.	.70 - .75	.70 - .75	.65 - .67
Benzoic acid, U.S.P., kgs., lb.	.54 - .56	.54 - .56	.52 - .54
Benzyl chloride, tech., dr., lb.	.25 - .27	.25 - .27	.25 - .27
Benzol, 90%, tanks, works, gal.	.16 - .18	.16 - .18	.16 - .18
Beta-napthol, tech., drums, lb.	.23 - .24	.23 - .24	.23 - .24
Cresol, U.S.P., dr., lb	.12 - .13	.12 - .13	.12 - .13
Cresylic acid, dr., wks., gal.	.87 - .89	.87 - .89	.92 - 1.00
Diethylaniline, dr., lb.	.40 - .45	.40 - .45	.55 - .58
Dinitrophenol, bbl., lb.	.23 - .25	.23 - .25	.23 - .25
Dinitrotoluen, bbl., lb.	.15 - .16	.15 - .16	.15 - .16
Dip oil, 15%, dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.	.32 - .36	.32 - .36	.32 - .36
H-acid, bbl., lb.	.50 - .55	.50 - .55	.50 - .55
Naphthalene, flake, bbl., lb.	.06½- .07	.06½- .07	.07½- .07½
Nitrobensene, dr., lb.	.08 - .09	.08 - .09	.08½- .10
Para-nitranilins, bbl., lb.	.50 - .52	.50 - .52	.45 - .47
Phenol, U.S.P., drums, lb.	.14½-	.14½-	.13½- .14
Picric acid, bbl., lb.	.35 - .40	.35 - .40	.30 - .40
Pyridine, dr., gal.	1.55 - 1.60	1.55 - 1.60	1.55 - 1.60
Resorcinal, tech., kegs, lb.	.75 - .80	.75 - .80	.75 - .80
Salicylic acid, tech., bbl., lb.	.33 - .40	.33 - .40	.34 - .40
Solvent naptha, w.w., tanks, gal.	.26 -	.30 -	.30 -
Toluidine, bbl., lb.	.88 - .90	.88 - .90	.88 - .90
Toluene, tanks, works, gal.	.26 -	.35 -	.35 -
Xylene, com, tanks, gal.	.26 -	.35 -	.35 -

MISCELLANEOUS

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb.	.07½- .12½	.06½- .12	.13 - .14
China clay, dom., f.o.b. mine, ton.	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors			
Carbon gas, black (wks.), lb.	.02½- .30	.02½- .30	.04 - .30
Prussian blue, bbl., lb.	.36 - .37	.36 - .37	.37 - .38
Ultramarine blue, bbl., lb.	.10 - .26	.10 - .26	.10 - .26
Chrome green, bbl., lb.	.21 - .30	.21 - .30	.26 - .27
Carmine red, tins, lb.	4.00 - 4.40	4.00 - 4.40	4.00 - 4.40
Para toner, lb.	.75 - .80	.75 - .80	.75 - .80
Vermilion, English, bbl., lb.	1.55 - 1.60	1.45 - 1.50	1.80 - 1.90
Chrome yellow, C. P., bbl., lb.	.14½- .15½	.14½- .15½	.13 - .14
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.06 - .06½	.06 - .06½	.06 - .06½
Gum copal Congo, bags, lb.	.06 - .30	.06 - .30	.08 - .30
Manila, bags, lb.	.07 - .14	.07 - .14	.09 - .14
Damar, Batavia, cases, lb.	.16 - .24	.16 - .24	.15½- .16
Kauri cases, lb.	.17½- .60	.17½- .60	.19 - .25
Kieselguhr (f.o.b. N. Y.), ton.	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	50.00 -	50.00 -	50.00 -
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .04	.03 - .04	.03 - .04
Rosin, H., bbl.	5.65 -	5.85 -	9.35 -
Turpentine, gal.	.28½-	.29 -	.39 -
Shellac, orange, fine, bags, lb.	.20 -	.20 -	.24 -
Bleached, bonedry, bags, lb.	.17 -	.16½-	.18 -
T. N. Bags, lb.	.11 -	.11 -	.12½-
Soapstone (f.o.b. Vt.), bags, ton.	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b. Ga.), ton.	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 -	13.75 -	13.75 -

INDUSTRIAL NOTES

SHEFFLER-GROSS CO., Philadelphia, has appointed the Specialty Products Co., Boston, as exclusive distributors in New England for Duoflo suction and discharge strainers.

KOPPERS CO., Pittsburgh, has transferred Frank F. Wise from the engineering and construction division to the western gas division where he will act as general manager. R. A. Wickes has become sales manager of the division.

MANN ENGINEERING CO., with headquarters at 429 Penn Ave., Pittsburgh, has been formed by Harvey B. Mann.

PANGBORN CORP., Hagerstown, Md., has moved its New England offices to 175 State St., Springfield, Mass. J. H. Connolly formerly connected with the company's Detroit office is in charge.

TITANIUM PIGMENT CORP., New York, is now represented in New England by Herman A. Pfeifer, who makes his headquarters in Boston.

RAYBESTOS-MANHATTAN, INC., the Manhattan Rubber Mfg. Division, Passaic, N. J., has appointed J. B. Wittrup manager of the Chicago mechanical rubber branch.

THE LINCOLN ELECTRIC CO., Cleveland, has appointed J. M. Chapple managing director of Lincoln Electric Co., Pty., Ltd., its recently established subsidiary at Lancaster, Australia.

STEARNS MAGNETIC MFG. CO., Milwaukee, has announced the appointment of the Delavan Engineering Co., Des Moines, as its sales representative for Iowa and adjacent territory.

THE FOXBORO CO., Foxboro, Mass., has moved its office and branch factory in Dallas, Tex., to 1710 No. Akard St.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1938	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	.....	$240,000	$879,000
Middle Atlantic	$1,000,000	$230,000	5,969,000	1,808,000
South	1,000,000	3,772,000	20,180,000	9,252,000
Middle West	.....	90,000	12,077,000	3,830,000
West of Mississippi	8,500,000	40,000	16,440,000	4,830,000
Far West	60,000	150,000	930,000	2,397,000
Canada	3,750,000	1,500,000	14,595,000	3,710,000
Total	$14,310,000	$5,782,000	$70,431,000	$26,706,000

PROPOSED WORK

Aluminum Fabricating Plant—Aluminum Co. of Canada, Arvida, Que., Can., contemplates the construction of an aluminum fabricating plant. Estimated cost $2,500,000.

Creosoting Plant — Northern Wood Preservers, Ltd., J. Prettie, Mgr., Port Arthur, Ont., Can., has acquired a site of 64 acres at Prince Albert, Sask., Can., and plans to construct a creosoting plant. Estimated cost $150,000.

Gypsum Plant—National Gypsum Co., 190 Delaware Ave., Buffalo, N. Y., plans to construct a gypsum plant near Savannah, Ga. Estimated cost $1,000,000.

Laboratory—U. S. Department of Agriculture, Washington, D. C., has had plans prepared by Ruhnau & Saunders, Archts., 3484 Jackson St., Riverside, Calif., for the construction of a group of laboratory buildings for the Rubidoux Laboratory, Riverside, Calif. Estimated cost $60,000.

Newsprint Mill—Southern Newspaper Publishers Assn., James G. Stahlman, Chn., Newsprint Mfg. Com., Nashville, Tenn., plans to construct newsprint mill at Lufkin, Tex., to be financed by Texas and Southern capital. This will be first newsprint mill in the South. Estimated cost $7,500,000.

Oil Refinery—Atlantic Refining Co., 260 South Broad St., Philadelphia, Pa., contemplates extensive improvements to its refinery at Philadelphia. Estimated cost will exceed $1,000,000.

Oil Refinery—Atlantic Refining Co., 260 South Broad St., Philadelphia, Pa., contemplates extensive improvements to its oil and gas refinery at Atreco, Tex. Estimated cost will exceed $1,000,000.

Oil Refinery—British American Oil Co., Ltd., Royal Bank Bldg., Toronto, Ont., Can., plans to construct an oil refinery to have a daily capacity of 5,000 bbl. Estimated cost $1,000,000.

Oil Refinery—Lake St. John Ore Co., Ltd., c/o Jacques Cosgrain, K.C., Quebec City, Que., Can., plans to construct an oil refinery. Estimated cost $50,000.

Varnish Factory — Canada Varnish Co., Ltd., R. E. Edwards, Pres., 53 Laird St., Leaside, Ont., Can., plans to construct an addition to its factory. Estimated cost $50,000.

Flotation Mill—Western Mines Corp., c/o B. E. Flynn, Route 3, Lewistown, Mont., plans to construct a 20-ton flotation mill.

Equipment—City and County of San Francisco, Department of Public Works, San Francisco, Calif., is in the market for two sand and rock dyers for the asphalt plant.

Blocking Machine — Industrial Minerals, Ltd., Edmonton, Alta., Can., is in the market for blocking machine and special filter at waterways salt plant. F. Batcheller, Gen. Mgr. Estimated cost $40,000.

CONTRACTS AWARDED

Chemical Plant—Ethyl-Dow Chemical Co., C. M. Shigley, Plant Mgr., Kure Beach, Wilmington, N. C., has awarded the contract for addition to plant to raise capacity for processing sea water from 137,000 gal. per min. to 200,000 gal. per min., to Austin Co., Euclid Ave., Cleveland, O. Estimated cost $2,500,000.

Cyanide Mill—Geysor Marion Gold Mining Co., F. B. Bothwell, Gen. Mgr., Mercur, Utah, will construct an 800 ton cyanide mill to be connected with the Company's present 300-ton mill. Work is under way. Estimated cost $150,000.

Factory—Agfa Ansco Co., Binghamton, N. Y., has awarded the contract for a 4 story, 73x170 ft. manufacturing building to Wark & Co., 1608 Walnut St., Philadelphia. Estimated cost $150,000.

Gasoline Cracking Plant—Evangeline Gasoline Co., Evangeline, La., N. P. Condry, Gen. Mgr., Jennings, La., will construct a large gasoline cracking plant in Evangeline. Work will be done by owners. Estimated cost $1,500,000.

Laboratory — Griffiths Laboratories, 1415 West 37th St., Chicago, Ill., have awarded the contract for a 2 story addition to their plant to Poirot Construction Co., 2001 Pershing Rd., Chicago. Estimated cost $40,000.

Paper Mill—Ecusta Paper Corp. of Delaware, Harry S. Strauss, Pres., c/o Champion Paper Corp., 345 West 40th St., New York, N. Y., has awarded the contract for the construction of a plant for the manufacture of cigarette paper near the Pisgah Forest Reservation, 2½ mi. north of Brevard, N. C., to Fiske-Carter Construction Co., Greenville, S. C. Estimated cost including equipment $2,000,000.

Paper Mill—Ontario Paper Co., Ltd., Thorold, Ont., Can., has awarded the contract for a drum barking plant, houses, wharf, log conveyor system, etc., at Heron Bay on Pic River, to A. W. Robertson Co., Ltd., 57 Bloor St., W., Toronto, Ont. Estimated cost $1,500,000.

Paper Mill—St. Regis Paper Co., Carthage, N. Y., has awarded the contract for a paper mill to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost including equipment $40,000.

Pipe Factory—Platte Valley Cement Mfg. Co., George F. Lillie, Jr., Fremont, Neb., will construct a 1 story, 30x30 ft. and 40x80 ft. pipe factory. Work will be done by day labor.

Roofing Felt Factory—Electric City Paper Mills, Inc., Adams St., Niagara Falls, N. Y., manufacturer of roofing felt, will rebuild its factory recently destroyed by fire. Work will be done by separate contracts.

Sewer Pipe Factory—Stillwater Clay Co., Uhrichsville, O., has awarded the contract for a 2 story factory for the manufacture of sewer pipe to replace the one destroyed by fire to Edward T. Jacobs, Coshocton, O. Estimated cost will exceed $50,000.

Sugar Refinery—Breaux Bridge Sugar Cooperative, Inc., Breaux Bridge, La., has awarded the contract for constructing cooperative sugar refinery near here, to Farrel Birmingham Co., Ansonia, Conn. Estimated cost $700,000.

Tire Factory—Armstrong Tire & Rubber Co., Inc., 475 Elm St., West Haven, Conn., has awarded the contract for a tire manufacturing plant at Natchez, Miss., to B. F. Knost, Pass Christian, Miss., at $272,456.

Oil Tanks—Atlantic Refining Co., 85 Doremus Ave., Newark, N. J., has awarded the contract for the construction of two 46x90 ft. oil tanks each having a capacity of 2,240,000 gal., to Chicago Bridge & Iron, 165 Bway., New York, N. Y.

INDUSTRIAL NOTES

PREMIER MILL CORP., Geneva, N. Y., now represented by H. B. Vollrath, 6733 Emlen St., Philadelphia. Mr. Vollrath will work in the territory comprising eastern Pennsylvania, southern New Jersey, Maryland, and Delaware.

THE B-L ELECTRIC MFG. CO., St. Louis, has appointed Arthur H. Baier as representative in Erie, Pa., and for the State of Ohio. Samuel K. Macdonald will represent the company in southern New Jersey, Pennsylvania, West Virginia, Virginia, Maryland, Delaware, and the District of Columbia.

MICHAEL J. LEAHY, consulting engineer, Fort Worth, Texas, has moved his office to 809 Nashville St., where he also has equipped a laboratory for research and development work.

THE KESSLER CHEMICAL CORP., Hoboken, N. J., has appointed the George Senn organization, its sales representative in the Philadelphia territory. L. C. Harvey, Jr., will be in charge of this sales division.

CENTURY ELECTRIC CO., St. Louis, has moved its New York office to 30 Vesey St. James Larkin is the district manager.

BARBER-GREENE CO., Aurora, Ill., has recently appointed new distributors as follows: A. R. Amos, Jr., Commercial Trust Bldg., Philadelphia; Columbia Equipment Co., Portland, Ore.; W. T. Jones Co., Salt Lake City; A. E. Hunt, Vancouver, B. C.; and T. Shuman Hower, Utica, N. Y.

GEORGE D. HARTLEY who recently returned from a survey of industrial conditions in European countries, has opened a consulting office at 311 Main St., Worcester, Mass.

DRIVER-HARRIS CO., Harrison, N. J., is now represented on the Pacific Coast by the Electrical Specialty Co., Ltd., San Francisco.

PRODUCTION AND SALES OF DYES AND OTHER SYNTHETIC ORGANIC CHEMICALS

THE Tariff Commission has issued preliminary figures for United States production and sales of dyes and other synthetic organic chemicals in 1937. Every group shows increased activity over the preceding year and in most cases represents all-time peak production. Among the coal-tar derivatives, the greatest increases over 1936 were shown by medicinals, flavors and perfume materials, and resins. The non-coal-tar synthetics continued to increase in quantity and variety and the output exceeded 2½ billion pounds in 1937. The value of sales of all synthetic chemicals exceeded $280,000,000, of which those from coal tar (including dyes) account for about 58 per cent and the non-coal-tar group about 42 per cent.

The peak production of 575,893,000 lb. of coal-tar intermediates represents an increase of 13 per cent over 1936. Outstanding gains in this group are shown by those largely used in synthetic resins. Phenol production totaled 65,690,000 lb. or 35 per cent more than in 1936, and the output of 45,211,000 lb. of phthalic anhydride represented a 45 per cent increase. Statistics for the cresols and maleic anhydride are shown separately for the first time. Other intermediates recording notable increases include b-hydroxy naphthoic acid 21 per cent, and p-dichlorobenzene 22 per cent. Most of the intermediates for dyes were produced in slightly greater quantities than in 1936.

The output of dyes was 2.2 per cent greater than in 1936 and totaled 122,208,000 lb. Sales increased less than 1 per cent in quantity and slightly over 1 per cent in value. Sales of classified dyes decreased 1.5 per cent in quantity and 2.2 per cent in value while the new and unclassified group shows a 13 per cent increase in quantity and 11 per cent increase in value. This latter group is increasing in importance each year and in 1937 accounted for 14 per cent of the sales quantity and 30 per cent of the sales value of all dyes.

Production of synthetic indigo increased slightly while sales quantity declined slightly as compared with 1936. The sales price averaged 17 cents per lb. as against 16 cents in the preceding year. Output of sulphur black decreased 7 per cent and sales quantity about 3 per cent.

Lakes and toners increased 12 per cent in production, 6 per cent in sales quantity, and 8 per cent in sales value in 1937 over 1936.

Synthetic medicinals were produced in increased quantity. Sales of those of coal-tar origin amounted to $11,496,045 and of those not of coal-tar origin to $2,408,371. Sales of aspirin increased 25 per cent to 5,143,672 lb. Sulfanilamide, a very minor item in 1936, showed sales of 267,104 lb. valued at $1,322,412 in 1937, the average value being $4.95 per lb. Mandelic acid and salts increased more than 200 per cent in output. Among the outstanding changes were sharp decreases in the prices of the arsphenamines and the several medicinal dyes. Of the medicinals of the non-coal-tar group, amino acetic acid, a relatively new medicinal, increased more than 100 per cent in production, 90 per cent in sales quantity, and 100 per cent in sales value over 1936. Average sales price was $1.86 per lb. as compared with $4.89 per lb. in 1933. Further decline in the production and sales of certain barbituric acid derivatives is noted.

Coumarin production increased about 100 per cent and sales about 36 per cent while the output of vanillin was 17 per cent greater and sales 26 per cent greater than the preceding year. Flavors and perfume materials from coal-tar, as a group, increased 25 per cent in production and 23 per cent in sales value. Appreciable increases are also shown for those not of coal-tar origin.

Activity in synthetic resins continues to increase with a record output exceeding 160,000,000 lb. in 1937 or 20 per cent more than in 1936. For the first time, the output of this class of synthetic products exceeded the output of dyes. The greatest increase is shown in non-coal-tar resins, 34 per cent gain over 1936, followed by alkyd resins with an increase of 30 per cent and tar acid resins 14 per cent.

Miscellaneous non-coal-tar synthetics reached the record output of 2,499,000,000 lb. or 24 per cent more than in 1936. Production of acetic anhydride increased 30 per cent and the increase in output of synthetic acetic acid was even greater. Acetone increased 31 per cent, butyl alcohols 65 per cent, and carbon tetrachloride 23 per cent in 1937 over 1936. A decreased output of 12 per cent is noted for ethyl acetate and 7 per cent for isopropyl alcohol.

Comparison of production and sales of dyes and other synthetic organic chemicals, 1936 and 1937

	1936	1937
Coal-tar chemicals		
Intermediates—		
Production, 1000 lb.	509,706	575,893
Sales, 1000 lb.	223,119	242,194
Sales value, $1000	31,806	35,639
Finished coal-tar products— [1]		
Production, 1000 lb.	[2] 336,348	[2] 371,124
Sales, 1000 lb.	[2] 287,276	[2] 313,797
Sales value, $1000	[2] 120,765	[2] 127,414
Dyes—		
Production, 1000 lb.	119,523	122,208
Sales, 1000 lb.	117,573	118,010
Sales value, $1000	63,686	64,531
Medicinals—		
Production, 1000 lb.	12,034	14,800
Sales, 1000 lb.	10,079	11,989
Sales value, $1000	9,763	11,496
Flavors and perfume materials—		
Production, 1000 lb.	3,481	4,348
Sales, 1000 lb.	3,437	3,899
Sales value, $1000	3,220	3,967
Coal-tar resins—		
Production, 1000 lb.	[3] 117,302	[3] 141,099
Sales, 1000 lb.	[3] 86,214	[3] 108,284
Sales value, $1000	[3] 17,056	[3] 20,165
Non-coal-tar chemicals—		
Production, 1000 lb.	2,041,456	2,523,893
Sales, 1000 lb.	1,034,921	1,168,058
Sales value, $1000	105,832	119,375

[1] Includes color lakes, rubber chemicals and miscellaneous coal-tar products not shown separately.

[2] Does not include resins from coumarone and indene, hydrocarbons, styrol, and sulfonamides.

[3] Does not include resins from adipic acid, coumarone and indene, hydrocarbons, styrol, succinic acid and sulfonamides.

Production and sales of certain miscellaneous synthetic chemical products, 1937

	Production lb.	Sales lb.	Sales value	Unit value
Coal-tar: Total	42,291,554	36,322,184	$8,023,340	$0.22
Photographic chemicals: Total	1,762,201	1,443,755	1,516,327	1.05
Hydroquinol	1,220,253	1,133,139	816,337	.72
Methyl p-aminophenol sulfate (metol) (rhodol)	205,987	.....	.....	.....
All other	335,961	310,616	699,990	2.25
Phthalates Total	15,082,440	13,282,818	2,496,314	.19
Dibutyl	6,963,625	5,760,967	986,295	.17
Diethyl	1,288,491	1,106,939	193,426	.17
All other	6,830,324	6,414,912	1,316,593	.20
Textile chemicals: Total	2,976,622	2,848,664	747,150	.26
Non-coal-tar: Total [1]	2,499,279,901	1,146,173,974	110,280,869	.10
Acetic acid (100% purity)	125,509,931	.....	.....	.....
Acetic anhydride (from all sources) (100% purity)	177,488,353	.....	.....	.....
Acetin (mono, di, tri)	144,152	130,080	40,378	.31
Acetone	124,012,187	68,772,268	3,586,971	.05
Amyl acetates, total	.....	11,796,710	1,236,678	.10
Amyl alcohols, total	14,205,997	.....	.....	.....
Butyl acetates, total	76,352,160	62,167,685	5,382,888	.09
Butyl alcohols, total	124,464,656	40,806,856	3,322,689	.08
Carbon tetrachloride	84,112,245	74,417,244	3,046,448	.04
Chloroform (tech and USP)	2,657,167	1,948,656	335,437	.17
Diacetone alcohol	3,063,136	.....	.....	.....
Dibutyl tartrate	22,058	.....	.....	.....
Ethyl acetate (85% purity)	63,971,921	44,339,330	2,910,222	.07
Gallic acid, tech	263,756	.....	.....	.....
Isopropyl alcohol (Isopropanol)	131,462,298	.....	.....	.....
Isopropyl ether	3,978,267	.....	.....	.....
Lactic acid: Edible	927,329	883,961	195,855	.22
Methanol (synthetic)	.....	125,313,631	4,827,626	.04
Methyl chloride (Chloromethane)	3,404,079	3,374,955	1,074,665	.32
Oxalic acid	10,247,541	9,605,180	1,030,137	.11
Pyrogallic acid (Pyrogallol)	115,027	99,812	118,614	1.19

[1] Includes non-coal-tar rubber chemicals.